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CHARLES H. SMITH
EDITOR
Hyde Park High School, Chicago

CHARLES M. TURTON
BUSINESS MANAGER
Bowen High School, Chicago

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PROCEEDINGS OF THE EIGHTEENTH MEETING OF THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS.

This meeting was held with the University of Chicago, November 29 and 30, 1918. All of the matter appearing on pages 197 to 271 in this volume was presented at this meeting which in many respects was the most important in the history of the Association. Some of the papers and reports have not yet come into the hands of the Publication Committee, although all who took part in the regular program have been asked to submit their papers to this committee.

The first session was called to order by the President, Harry D. Abells, of the Morgan Park Military Academy, in the Auditorium of the Ida Noyes Hall. Vice-President Angell of the University gave the address of welcome. It was extra cordial, he expressing the willingness on the part of the University to cooperate in all ways possible in helping the Association in the great work it is doing in raising the standard of science teaching. Mr. Herbert R. Smith of the Lake View High School, Chicago, responded as follows:

RESPONSE.

To Dean Angell and the University of Chicago I express the appreciation of the members of the Central Association of Science and Mathematics Teachers for the generous hospitality extended on this occasion of the Association's eighteenth meeting. We have long known that the University's latchstring hangs out for us when we meet in Chicago; and our joy and comfort experienced on previous occasions bring us here again.

This meeting means more to us than a formal visit at the University. The names of many distinguished members of its faculty may be found on our membership roll. They have been a powerful factor in the Association work in secondary education. Their advice and leadership have been proved sound

and fruitful on many an occasion. We feel that we are visiting the home of our comrades in education. A large per cent of our members have at some time been numbered among the student body of the University, while perfecting their knowledge and methods of teaching; and some of us are proud to name the university as alma mater, so our meeting today partakes of the nature of a home coming for the Thanksgiving holidays.

It is easy to say the friendly word, and to wish us good luck; but you give us material support as well. We greatly appreciate the cost and labor that you expend to meet our every need. By these tokens we know the University as an unfailing friend that helps us on our wished-for way.

Sir, there are those who call themselves friends who have advised that we cancel our meeting this year in view of the exigencies of the times. We cannot help wondering just how much they know of our aims and work. President Wilson and other war leaders have plainly spoken of the necessity of education in war time. If these utterances are not enough to convince the most skeptical, there is the significance of the collapse of civilian and soldier morale, due to a lack of education. If education is more necessary in war time, then it is sound logic to have more efficient education in these times. We are here for that purpose.

There are also those who have declared that the publication of this program is an unpatriotic waste of paper. By this we are reminded of one called Judas, who denounced the unselfish efforts of others as an uncharitable waste.

But these incidents move us only to greater efforts. You believe in our work and have also proved your belief. We must then believe in ourselves.

We confess that there were times in our more youthful days of teaching when we admitted to our friends that we were teaching only until something better presented itself. But the passing years have brought us wisdom, and in the realization that we have the wonderful opportunity of shaping youthful minds as they enter upon manhood and womanhood's estate, we declare to you now that we as teachers will not give place to any vocation as more sacred than our own—not even excepting that of the clergy.

Our writers and orators are just beginning their praise of the deeds of the American boys at Cantigny, Chateau-Thierry, and the Argonne. To us all their spirit and valor are a never-ending wonder. With less than a year's training for the battle

line, they checked and flung back the proudest and best-trained soldiery of Europe, and upheld Liberty's banner as worthy descendants of the men of 1776 and 1861.

While comparatively few of our members have gone to the strife or have sons at the front, yet most of us have a score or more of former pupils overseas. We are as proud of their achievements as their own parents. And we are told that we have a right to be, for the morale of the American boys is due more to their education than any other single factor.

Even if this relation were only remotely true, then this idea is sufficient cause and inspiration for us to solemnly declare that if our hitherto haphazard and half-hearted efforts at training the minds of the American youth can make men of such heroic mold, then humanity shall yet receive more liberal gifts from the American nation because of our efforts.

Such is the temper of our purpose as we meet here to exchange ideas, plan and improve our methods of teaching. In this spirit do we honor your hospitality.

PROGRESSIVE SCIENCE AND MATHEMATICS COURSES AND TEACHING IN FRANCE.

By A. Barthelemy,

Consul for France at Chicago.

In France we have remained very much attached to classical culture. It is thought, with justice, that in order to know French well, it is necessary to have learned Latin. But the necessity in which we have all found ourselves, to keep up with the times, has led us to give a larger place to the teaching of sciences in our programs. And we have done this with such success as far as the teaching of mathematics at least is concerned, that in May, 1914, Professor Stackel, former Rector of the University of Carlsruhe, after having described instruction in France, exclaimed, "How different from Germany!" Adding that he hoped the latter would make a point of emulating us.

I should like also to call your attention to this point, that although France is a country of great centralization, teachers have more freedom than is generally believed, which permits them to make interesting experiments in the coordination of the various subjects, the association for instance of geometric drawings with various questions of optics.

In France, care is taken to give the students not only the necessary information for practical applications, but also intellectual

training. Thus one of the statements relative to elementary instruction says, "The subjects treated are chosen in such a way that they not only provide the child with all the practical knowledge which he will need in life, but they also develop his faculties, form his mind, cultivate it, broaden it, and truly constitute an education."

Many changes have been made in the programs of secondary instruction, introducing gradually into the classical teaching notions which were formerly considered as belonging to the higher courses. Thus even the students of the Latin-Greek and Latin Modern Language classes, that is the classes which are not scientific, are introduced to trigonometry and to graphic representations of size, which have now become almost indispensable for a cultured man.

But let us go more into detail.

Instruction in France is divided into three orders: primary, secondary, and superior.

The primary instruction leads to the *certificat d'etudes primaires* (certificate of primary studies). The upper primary schools lead to the *brevet simple* and to the *brevet superieur*. You know that the primary school is obligatory in France until one has obtained the certificate or reached the age of fourteen years. Let us take the most modest elementary school, the studies ending after the middle course. The little pupil of a small rural center generally does not continue his instruction beyond that point. In principle, the elementary school leads into the superior course, which may be followed by the complementary course of the *ecole superieure*. But let us see what is the minimum instruction given in principle and in fact to the little French pupils.

The scientific instruction occupies, on the average, an hour to an hour and a half per day; that is, three-quarters of an hour or an hour for arithmetic or the exercises which are connected with it, the rest for lessons about things and the first scientific notions. This is about half the time which is devoted to French.

An examination of the curricula shows, in addition, that in regard to arithmetic, in the classes for small children and in the elementary course, the teacher limits himself to teaching his students the four fundamental operations, and to giving them some notion of the metric system. The little problems are exercises in calculation, reproducing, with different elements or associating according to very simple elements, the operations

the mechanism of which has become familiar to the students. The instruction should be essentially concrete. They are not asked to add twenty-seven and forty-one; they will be asked, for example, to calculate the total number of marbles contained in a sack in which there were forty-one marbles and into which twenty-seven more have been put. It is by means of little sticks, beans, pebbles, and balls that the elementary notions contained in the courses of study in numbers, addition, and subtraction will have been taught. The slate will also play an important role in this first study.

In the same way for the teaching of the metric system, all the classrooms have, in addition to the charts with the usual units of length, area, weight, and volume, a metric compendium which contains the objects and instruments necessary for actual measurements.

Considerable increase in the number of exercises in mental calculation is recommended. Well-directed and limited each time to a rather short period, they constitute mental gymnastics, which the children practice with pleasure, which quickens their minds, and which makes numbers live for them.

In the intermediate course, the attention given to the exercise of the reason is increased. Up to this point, the little pupil has learned especially to add, subtract, multiply, and divide, realizing always, of course, the utility of each of these operations. It is now necessary to combine by work in intuitive logic, various operations with a definite end in view.

Theoretical demonstrations gradually form a part of the instruction of the teacher; study of the characters of divisibility, explanation of the proof by 9, a general idea of fractions. It is advisable to limit strictly this domain of theory. The course of study in arithmetic in the intermediate course does not have for its purpose the complete clearness of an exact demonstration apropos of all of the knowledge acquired. But the initiation, even incomplete, into logic, imposes habits of order in thought, of sincerity in expression, which confirms the written work and the material explanation of the solution.

The study of the metric system is also fairly developed in the intermediate course. Under various aspects there appear to the pupil sizes of various nature, which are measurable and which the practice in everyday life obliges him to evaluate. The evaluation involves experimental determination; the intellectual work becomes a bit complicated, and should be subjected to

greater discipline. Courses of study in geometry, in drawing, in manual training—naturally very modest and not including any theoretical instruction—bear in mind the needs of the instruction in the metric system.

By "common elements of the physical and natural sciences," to which the courses of study devote about two hours per week, we are to understand lessons about objects. No developed course is meant by this. To gather facts concerning the sciences, to control these facts, to connect them by a line of reasoning whose elaboration sets to work the faculties of reflection and perspicacity—that is the work which it is proposed to give the child.

The difficulty lies in the choice of the material of the lessons. As it is necessary to limit oneself to observations which can be made directly by the students, the subjects taken up generally vary from one school to another. The orientation is in the direction of notions concerning hygiene, of knowledge useful to agriculturists, of notions useful to girls.

Thus the utilitarian aspect proper to the elementary school appears immediately.

In the upper primary instruction, the courses of study should be considered merely as outlines. The professor is free to adopt whatever order suits him, to choose the methods which may seem most profitable to him. The number of practical exercises should be increased, theory should be reduced to explanations, having to do for the most part with concrete examples. The object in view is to make more exact the knowledge acquired. The pupils are to be given practice in mental calculation at every opportunity. The teacher will frequently make use of graphic representations, a method which is of very great service in the study of physics as well as in numerous aspects of arithmetic.

The secondary instruction is given in the *lycees* and in the *colleges*, where the children may also receive their elementary instruction. Reaching the sixth class, the child is supposed to decide whether he will follow the classic or the modern courses. Two years later a new division of courses leads the student to one of the four following (*baccalaureats*): Bachelor's Degrees; A—Latin, Greek, and one modern language; B—Latin, no Greek, two modern languages; C—Latin, sciences, one modern language; D—Sciences and two modern languages.

In science—I am now speaking of mathematics—the professor avoids all theory; his object must be to teach the students

to perform the operations correctly and to accustom them by numerous examples to the significance of these operations. The definitions, in particular those which concern fractions, are constantly reinforced by concrete examples. In working with the metric system, rules of interest, etc., the teacher begins to accustom his students to the use of letters and simple formulas which naturally come up.

The fifth class introduces the use of algebraic method. In a general way it is only little by little that the students are accustomed to abstract notions. The teachers are urged not to overload the courses, to use books liberally, not to overdo the use of general theory, not to teach any theory without making numerous explanations of it, to begin regularly with the most simple cases, those easiest to understand, in order to pass from them to general theorems. These recommendations apply to all the classes, and make it unnecessary for me to go into details which would try your patience. The important point is to develop the judgment and the initiative of the students, not their memory.

We have a criterion in this respect. How do the secondary studies prepare for the various faculties? Very well as far as mathematics is concerned, thanks especially to the special mathematics classes of the *lycees*, which prepare the student for the Polytechnic, Normal, Superior, and Central schools, and permit the student to make various advanced studies (analytical geometry, algebra, etc.). The conditions are very much the same for physics and for chemistry, but the instruction in the natural sciences is much less favored in the secondary schools. The result is that the faculties of science have always drawn many students of good quality for mathematics, and that they have felt the need of strengthening the basis of their studies in the other sciences.

Honor is due to the Third French Republic for having strongly organized secondary education for girls. It includes five years of study from the age of twelve to seventeen. In the first year arithmetic is taught from the practical point of view. The course in geometry aims at initiating the student into constructions and the knowledge of geometric forms. It teaches the applications of the metric system. More developed in the second year, the instruction in arithmetic should contain as little theory as possible. In the third year algebra and physics make their appearance. In physics the tendency is to guard

carefully against too many facts, and, while bringing this science down to our day, to leave aside everything which in the incessant progress of events has become useless (out of date). The instruction in the sciences is carried through the fourth and fifth years, and even through the sixth year for those girls who are preparing for special schools or careers.

You see, ladies and gentlemen, what the tendency is—entirely practical. The instruction grows with the child until it reaches its maturity in the faculties of science, which of course are not included in this study. I think one may say of France, that she is following an excellent plan. She has had great savants since Fermat, whom no one perhaps has equaled. I am speaking now of mathematics. Galois renewed algebra. Descartes founded analytical geometry. Pascal remade the theory of conic section. Monge invented descriptive geometry. Then there are Lalande, Ampere, Novier, Henri Poincare, Hermite, Darboux, Picard, Appell, Painleve. In the other branches of science, how many names I could cite! I might perhaps have shown better what France is doing for the instruction in sciences if the many things I have had to do had left me the leisure for it, and, to tell the truth, if my incompetence had not prevented me.

REPORT OF BUSINESS MEETING.

President Abells presided.

The minutes of the business meeting of 1917 were read and approved.

The Auditing Committee reported that the Treasurer's books were correct. The Treasurer's report was read and accepted. The Treasurer read the report of the Membership Committee. The report was accepted.

Mr. Shinn, Chairman of the Resolutions Committee, read the following resolutions, which were adopted:

"*Whereas,* The needs of schools for illustrative, demonstration, and laboratory equipment call for material of good quality and proven utility, even more than ever before; and

"*Whereas,* The school directors and boards of education in nearly all communities know little of the pedagogic value of such materials frequently offered them for purchase; and

"*Whereas,* Many unscrupulous dealers and agents are engaged solely in selling such inferior material to uninformed and unsuspecting school authorities to the great financial loss and educational detriment of the communities concerned; therefore be it

"RESOLVED, That the Central Association of Science and Mathematics Teachers requests the Superintendents of Public Instruction in the Central States to curb the activities of unscrupulous dealers in school supplies and of those selling inferior goods, either by enforcement of legislation now existing or by the enactment of necessary law; or by such other methods as may be desirable; and that this Association pledges its support in the performance of such protective measures.

"*Whereas*, The events of the world war of 1914-1918 have laid bare certain fallacies of current secondary instruction, and the reconstruction and readjustment ensuing upon its settlement will necessitate corresponding pedagogical readjustments and reconstructions; and

"*Whereas*, The National Bureau of Education has pointed out certain of these necessary changes in educational matter and educational method; therefore be it

"RESOLVED, That the Central Association of Science and Mathematics Teachers pledges to the Government its collective and individual assistance in bringing about a form of education which shall reach a larger number of pupils, shall contribute more toward their culture and their efficiency, and shall prepare scientifically trained workers for rural and urban vocations.

"*Whereas*, The University of Chicago has again extended its hospitality and the courtesies of its faculties and equipment to the Central Association of Science and Mathematics Teachers for the 1918 meeting of the Association; therefore be it

"RESOLVED, That this Association, through its Secretary, convey to the University its hearty thanks for this hospitality, and its keen appreciation of the continuous efforts on the part of the University for the uplift and betterment of general education in this country.

"H. B. SHINN,
"*Chairman.*"

Mr. Clarence E. Comstock made the following report of the Committee on Necrology:

"The committee reports the death of but one member.

"Charles Byron Tibbitts met his death on June 30, 1917, by the falling of a water tank that was struck by the Steamship Christopher Columbus at Milwaukee. He was with a party of summer students from the University of Chicago when the accident occurred.

"Mr. Tibbitts was born at Berwick, Maine, February 10, 1890. He graduated from Bates College in 1913, was instructor in mathematics and physics in Lake Forest University from 1913 to 1915, and in James Milliken University from 1915 to the time of his death. He was a student at the University of Chicago in the summers of 1916 and 1917. He was a member of this Association from 1915.

"CLARENCE E. COMSTOCK, *Chairman.*"

The report was accepted.

Mr. H. R. Smith, Chairman of the Committee on Advertising, asked that the members of the Association speak a word of encouragement to our advertisers. It was moved and seconded that the Committee on Advertising be highly commended for its excellent work, and that we extend to it the thanks of the Association. Carried.

Chairman Charles H. Smith made the following report of the Committee on Nominations:

For President—Jerome Isenbarger, Nicholas Senn High School, Chicago, Ill.

For Vice-President—Fred T. Ullrich, Normal School, Platteville, Wis.

For Secretary—Harry O. Gillet, School of Education, The University of Chicago.

For Corresponding Secretary—D. A. Lehman, Purdue University, LaFayette, Ind.

For Assistant Treasurer—G. H. Crandall, Culver, Ind.

It was moved, seconded, and carried that the Secretary be instructed to cast the white ballot of the Association for the officers named. They were declared duly elected.

It was moved, seconded, and carried that a fund of $25 be placed at the disposal of the Executive Committee for the purpose of engaging the services of a stenographer to record the speeches and notes at the general meetings.

A rising vote of thanks was accorded the authorities of the Morgan Park Military Academy for the complimentary luncheon given to the Executive Committee, Friday noon.

Mr. Tower, representing the Executive Committee, brought to the attention of the members of the Association the question of the cost of School Science and Mathematics. He stated that it was no longer possible for the publishers of the journal to furnish it to members at the present price of $1.50 per member, as the actual cost is from $1.65 to $1.70 per member.

It was moved, seconded, and carried that the Central Association of Science and Mathematics Teachers pay the sum of $1.75 per member to the publishers of School Science and Mathematics, and that the publication of the *Proceedings* be discontinued for one year.

It was moved, seconded, and carried that the Committee on Science and Mathematics in the High School of Tomorrow be discharged.

It was moved, seconded, and carried that there be a Committee on Reconstruction, to consist of Mr. Downing as Chairman and one member from each of the sections of this Association, whose duty it shall be to work on the problems of the reconstruction of the high school programs of science and mathematics.

It was moved, seconded, and carried that each section be requested to appoint a Lookout Committee to report to the section on the action it should take on the question of the reconstruction of its special high school subjects.

It was moved, seconded, and carried that the Association recommend to the Executive Committee that one of the two sessions of the sections next year be a joint meeting in which the sections shall be invited to present problems of the separate sections for consideration by members of all the sections.

It was moved, seconded, and carried that the following resolutions be adopted for the guidance of the Reconstruction Committee:

1. Instruction in science for the first two high school years should be such as to put the child in an understanding and appreciation of his environment, that he may become a better social being, a better citizen.

2. That this instruction should be such as will contribute to the further development of any science he may choose to pursue.

3. These aims and principles should be incorporated within the material content of the course in general or fundamental science.

It was moved, seconded, and carried that the following statement of aims be referred to each section:

1. Each section should formulate in writing its chief objectives in the teaching of that subject.

2. Each section should consider the means now being used to realize these objectives, and change and perfect them to realize the objectives *at once*.

3. Each section should by committee or otherwise plan definite development work for the next year by assigning each member of that section a definite field for this development work.

4. The results of this work during the year should be the basis for one of the section meetings next November.

It was moved, seconded, and carried that Article IV of the Constitution be amended in accordance with the printed notice in the November issue of SCHOOL SCIENCE AND MATHEMATICS.

"This Association shall be divided into sections as follows: Biology, Chemistry, Earth Science, General Science, Home Economics, Mathematics and Astronomy, and Physics."

The Secretary was instructed to write notes of thanks to Dr. Andrew C. McLaughlin, Dr. Julius Stieglitz, and A. Bartholemy, Consul for France, and to the various places visited on the excursions: the Tack Works, the Stock Show, and the Schulze Bakery.

The meeting adjourned.

MINUTES OF THE MEETING OF THE EXECUTIVE COMMITTEE, NOVEMBER 30, 1918.

The meeting was called to order by the retiring President, Mr. Abells, at 1:30 p. m. After a few well-chosen remarks, expressing his appreciation of the loyal support given him during the past year by the members of the Association, and calling the attention of the committee to some of the more important and pressing questions to be considered by the committee in the immediate future, he called the President elect, Mr. Isenbarger, to the chair.

Invitations to hold the meeting of 1919 at the Lake View High School, Chicago, were read, followed by invitations from Cincinnati, Ohio. It was moved, seconded, and carried that the 1919 meeting of the Central association of Science and Mathematics Teachers be held in Chicago. It was moved, seconded, and carried that the invitation from the Lake View High School, Chicago, be accepted.

It was moved and seconded that the Chair appoint a committee of three to select a suitable theme for the 1919 program and present the same at the meeting of the Executive Committee in January. Carried.

It was moved and seconded that the publishers of SCHOOL SCIENCE AND MATHEMATICS be remunerated for all subscriptions received from members of the Association since September, 1918, so as to make the amount $1.75 for each subscription instead of $1.50. Carried.

It was moved and seconded that the Friday evening meeting at the annual convention be a joint meeting of all the sections around a common table to discuss the questions of reconstruction. Carried.

It was moved and seconded that the committee authorized at the general meeting of the Association, Saturday, November 30, Dr. Downing, Chairman, be known as the Reconstruction Committee. Carried.

It was moved and seconded that the Chair be, and hereby is, authorized to appoint the following committees: Committee on Resolutions, Committee on Advertising, Committee on Membership, Committee on Publicity, Committee on Necrology, Committee on Auditing, Committee on Nominations, and that the Committee on Resolutions report at the next Executive Committee meeting on the subject of a general theme for the program of 1919. Carried.

It was moved, seconded, and carried that the next Executive Committee meeting be held at the Hotel LaSalle at 10 a. m. on January 18, 1919. Carried.

It was suggested that the colors used at the meeting of 1918 be retained for the meeting of 1919, and that mention of the colors be made in the program.

Meeting adjourned.

A. W. CAVANAUGH,
Acting Secretary.

TREASURER'S REPORT, NOVEMBER 29, 1918.

RECEIPTS.

Balance at previous report		$ 410.66
Refund on 1917 Membership Committee expense		4.45
Ten copies *Proceedings*		5.00
Advertisements in 1917 Program		303.50
Advertisements in 1918 Program		100.00
Membership dues at $2.50	$1,780.00	
Membership dues, irregular	43.15	
Total membership dues		1,823.15
Total receipts		$2,646.76

EXPENDITURES.

Subscriptions to SCHOOL SCIENCE AND MATHEMATICS		$ 991.25
Subscriptions to *Amer. Journal of Home Economics*		101.50
Proceedings 1917, printing and distributing		328.09
Programs 1917, printing and distributing		338.21
Biology Section, expense	$ 30.00	
Earth Science Section, expense	5.00	
Mathematics Section, expense	15.00	
Badges, 1917	12.60	
Convention speakers, 1917	38.95	
President's expense	17.38	
Membership Committee expense	114.56	
Secretary's expense	10.53	
Treasurer's expense, postage	67.66	
Treasurer's clerical expense, 1916-1917	50.00	
Treasurer's bond, 1917-1918	2.50	
Advertising Committee expense	1.67	
Printing and stationery	55.90	
Transportation Committee, expense	2.25	
High School of Tomorrow Committee, expense	11.84	435.84
Balance		451.87
		$2,646.76

MEMBERSHIP REPORT FOR THE YEAR ENDING NOVEMBER 29, 1918.

Paid-up membership, November 30, 1917	990	
Honorary membership	9	
Total membership	999	
Delinquent, but left on the list as per Constitution	181	
Total names remaining on the list, November 29, 1918	1,180	
New names added during the year	187	
Total		1367
Resigned during the year	133	
Deceased or dropped for delinquency	81	214
Net Constitutional membership, November 29, 1918		1143
Paid-up membership, November 29, 1918		977

JOHN H. MCCLELLAN,
Treasurer.

THE FUNCTION OF ZOOLOGY IN THE CURRICULUM OF THE MODERN HIGH SCHOOL.

By Dr. Will Scott,

University of Indiana, Bloomington.

In order to understand function it is always necessary to understand clearly the mechanism that is to function. If I can make clear some of my notions concerning the anatomy of the high school course in zoology, I trust that its functions will be more or less obvious.

We are all agreed that the teacher of zoology should have not only the broadest possible training in the academic side of his subject, but that he should have acquired some common sense and skill in the organization and presentation of this subject matter.

Zoology is taught in about three per cent of the commissioned and accredited high schools of Indiana, and is in general disrepute. This is in part due to the fact that about twenty-five years ago many teachers undertook the subject that had neither of the above qualifications.

We are also agreed that the student should work in a first-hand intimate way with the materials of the subject. The laboratory has become so much a matter of course that I think, at times, we do not realize the difference in quality between the ideas which the student acquires for himself and the things we tell him or those about which he reads.

I am tempted to quote from an address delivered by David Starr Jordan when he was making a fight for laboratory work in zoology. "There is a charm about real knowledge which every student feels.

"The magnet attracts iron, to be sure, to the student who has learned the fact from the book, but the fact is real only to the student who has felt it pull. It is more than this—it is enchanting to the student who has discovered the fact for himself. To read a statement of the fact gives knowledge, more or less complete, as the book is accurate or the memory retentive. To verify the fact gives training; to discover it gives inspiration. Training and inspiration, not the facts themselves, are the justification of science teaching. Facts enough we can gather later in life, when we are too old to be trained or inspired. He whose knowledge comes from authority, or is derived from books alone, has no notion of the force of an idea brought first-hand from human experience."

On the third point we may not agree, namely, that zoology (or any biological subject) is intrinsically much more difficult than either physics or chemistry. I was glad to have such an eminent physicist as Professor Milligan say before this Association that physics could and should be taught in the ninth year, and that for his son at least it should precede biology. I am convinced that zoology should follow the physical sciences instead of preceding them.

What you can say to a ninth-year student about an animal's respiration, digestion, and excretion is bound to be more or less superficial and formal, while the student who has had some chemistry and knows something of the laws of gases, will understand these processes much more fundamentally.

For instance, if on your fall field trip to a pond, the question arises of how and where frogs and tadpoles spend the winter, the explanation to a ninth-year pupil will be little more than descriptive. However, if he knows something of Vant, Hoff's Law for a chemical reaction, the explanation will be fundamental, illuminating, and full of interest.

In making this plea for a solid course in the eleventh or twelfth year, I must point out the pernicious tendency of the last two decades to attain quickly and early in the course the so-called practical. It has been due, possibly, to our great industrial development; and since we are probably on the eve of a still greater industrial and commercial expansion, this influence will continue.

The Federal Government has recently appropriated some millions of dollars to this movement. My own state is to spend nearly $100,000 this year in its development.

There is much of value in all this, but there are also some heart-rendering losses. A boy may be taught a trade, but that very thing, by its immediate return, may prevent his becoming an engineer.

This whole movement is an attempt to give the student something that he can "cash in" at the earliest possible moment, or to impart something that he can use at once, in home or shop.

I need not elaborate this point. We have had high schools, manual training high schools, technical high schools, and finally trade schools. Every subject in the curriculum has been affected, and zoology has not escaped. There has been zoology, economic zoology, civic biology, applied biology, and finally meeting the

evaporated ends of other sciences it has lost itself in the clouds of general science and household economics.

Much of the so-called practical is, to my mind, very impractical because it is so particular. The more general a fact is, the more powerful it is, and hence in the long run the more practical. As Poincare puts it: "This shows us how we can choose: the most interesting facts are those which serve many times; these are the facts which have a chance of coming up again. We have been so fortunate as to be born in a world where there are such."

May I illustrate from zoology? Many teachers, especially in the secondary schools, begin their course in the fall with the study of insects. This is, I think, a very sensible point of departure. They study the potato beetle, the cabbage butterfly with its destructive larvae, the house fly with its relation to typhoid, etc. The most practical fact, however, that a student gets from these studies is a knowldge of the insect orders, together with the life histories characteristic of each.

If he have these facts well in mind, he will be able to handle pretty well any insect that may attack his plants. He can infer its life history from its structure. He can make a good guess as to how to attack it, and when. He knows at once whether he can poison it or whether he will have to use a contact spray.

We all teach the mosquito and its relation to malaria. In doing the latter, we imagine that we are very practical. The story of the malarial parasite is a very interesting one, and I shall always tell it; but the elementary student really learns very little from it concerning this or any other parasite. Even if you had a set of blood slides, they are rather difficult, and even if this could be well done, it would be only half of the story.

The best thing that the student gains from the study is a first-hand knowledge, from living material, of the life history of an insect with complete metamorphosis, with all of the changes in respiration, feeding movement, and habitat which accompany it.

May I offer just one illustration of another type of study? In the larger tadpoles that occur in almost any pond, you will find a trematode infection of the alimentary tract. If the student is assisted a little by his teacher, he can take a bent pin and hook the young or larvae of the trematode from the liver of the snails associated with the tadpoles. From this material he may learn something of the effect of parasitism on both host and parasite; something of the delicate adjustment between the two, and the

necessity of the second host, of the right sort, being present at the right time; that one animal may endanger the life of another; that the destruction of one host may save the other. He sees why the carnivora especially are subject to attack by certain forms. Now these tadpoles and snails are of no economic importance, but the facts and principles mastered in this study lie at the bottom of much pathology, nearly all tropical medicine, and all modern meat inspection.

A part of the plea for the practical has been due to a revolt against the so-called "type course." This course was chiefly morphological. It was designed by Huxley and Martin at a time when the uproar among the laymen over Darwinism was at its height. In fact, when Martin gave the course at Hopkins for the first time, the students petitioned at its close for a course of lectures on evolution. It was an excellent course, but has been followed far too slavishly in the colleges, and I am sure that neither of these great teachers would have thought of presenting it in the high school.

In this revolt, we have been told to study the things at hand; to put the time in on things that touch the student every day. To this everyone that has first-hand knowledge of conditions will subscribe. A starfish is a very dead thing to a student who has never seen one outside a pickling jar.

Here is one of the places that zoology differs from the physical sciences. A chemical desk in a Chicago high school and one in an Indianapolis high school have essentially the same outfit of reagents, while the zoological laboratories differ widely in the materials used. It is this that makes zoology at once the easiest and the most difficult of subjects. It is easy, because everywhere there is a wealth of material; but the selection and organization of this material, so that worth-while ends may be attained, is a task that calls for scholarship and the finest sort of judgment.

It is here that our vision is, I think, a bit clouded. Sometimes we fail to distinguish between the method of approach and the end to be attained. The end cannot be reached directly, and the methods of approach are varied.

The student must begin with particular studies. He works out the structure of an animal, infers some of its functions from structure, and determines others by experiment. The second animal may show clearly the circulation of the blood which had to be inferred in the first one.

He observes Paramoecium divide, and so form two individuals

from one. By keeping some snails in a jar on his table, he may see the tiny clusters of eggs laid, develop into rotating larvae, and finally into snails like the adult. If he has luck, he may get some freshly laid frog eggs, and with a hand lens watch the eggs divide and see some of the grosser differentiations in their development. Gradually he builds up some notion of reproduction and the physical basis of heredity. Whether or not to this is added, in a simple way, some of the modern notions of inheritance, these basic facts will steady his judgment when at forty he reads in his favorite magazine a series of articles on eugenics.

If with a can of earthworms in the laboratory, he repeats Darwin's simple experiments of feeding them bits of cabbage leaves, he not only learns something of the earthworm but something of enzymes and their action, which is not limited to the earthworm, but is just as true for himself and all other animals.

By studying the tracheae of insects, the booklungs of spiders, and the lung of a turtle, he gradually sees that the delicate respiratory surface in all air-breathing animals must be protected from evaporation, and consequently must be tucked inside the body. His knowledge of gases shows him that such a structure would be impossible in water, and the necessity of gills in aquatic animals becomes apparent. He finally sees that the purpose in all this mechanical variety is to get the oxygen as close as possible to the living cell or the blood stream, and to make the delivery of it rapid and constant, and that in all cases the fundamental process is the same.

Thus he gradually gains a knowledge of animal morphology, together with the functions of living matter, and the laws that govern it. This is the criterion by which we may evaulate our courses. It does not matter whether you begin with the grasshopper or the mosquito and I begin with the crayfish, but it is of prime importance that we know what facts are both fundamental and significant.

I must be sure that I am not misunderstood on three points. First, make all of the applications that you can. For the more applications of a law the student sees, the more significant the general fact becomes. Second, by my remarks on the "type course" I do not mean to belittle morphology, for it always must be primary in any biological study. Third, because I have selected my illustrations at random, do not think that the course is to be a hodgepodge. It is to be as logical and coherent as you have brains to make it from the materials at your disposal.

Another thing that the student should get from the course is some knowledge of sources. I do not mean complete knowledge of original sources such as a research worker demands; but he should know some good books on the various phases of the subject and have some notion of what they contain. He should know something of the various series published by the Government and how they may be obtained. What you can do for him in this direction will depend on your situation and the library facilities at your disposal. By knowing something of sources he can help himself after he leaves your hands.

Most of these students will never go to college. The high school is the last chance for them to learn something of the fundamental structure of the organic world of which they are a part, together with its functions and the laws by which it is controlled. To this training they have a right, and to supply this training is the function of zoology in the modern high school. It is one of the most difficult subjects in the curriculum, but when properly taught none is richer in permanent values.

COURSE IN AGRICULTURE FOR A FOUR-YEAR HIGH SCHOOL.

By Fred T. Ullrich,
State Normal School, Platteville, Wis.

In the discussion of this subject, at the very outset a query that may present itself is the advisability of the consideration of a course in agriculture for a high school on the four-year basis. Today, many of the elementary and secondary schools of the country are in the process of adjustment to one of the junior-senior plans of high school organization. It may be true that the best educational thinking recommends, and that recent experiments have demonstrated, the superiority of the junior-senior organization over the four-year plan, Nevertheless, the fact is that most of the high schools that give agricultural instruction are four-year high schools. In addition, the national legislation, the Smith-Hughes Law of February 23, 1917, which grants national funds for secondary agricultural instruction, stipulates among other requirements that the federal funds must be utilized for the education of persons over fourteen years of age. If these federal funds are to go to the schools now in operation, instead of a new type of agricultural high school, the four-year organization will more readily meet the provisions of this act than the new junior-senior high schools. It also may be said that any

fundamental principles for the organization of a course in agriculture on the four-year basis are also applicable to an agriculture course in a junior-senior high school.

Many of the questions relative to a course in agriculture for a four-year high school cannot be answered scientifically, at the present time. The difficulty lies in the absence of scientific methods for investigation and treatment of facts inherent in these problems. The development of new methods for educational inquiry and the summation of resultant discoveries must await the arrival of new ability, or the creation of an interest in these matters by those who have the mental equipment. Before all of these scientific solutions are available, several generations of boys and girls will have entered and left the high school. In the meantime, the only hope is to exchange opinions. In this study of a course of study in agriculture for a four-year high school, the results are essentially a collation of judgments of fifty leading educators of the country. A fair degree of validity should be accredited to these conclusions, because in any scientific investigation opinion or hypothesis will always remain a vital element. Indeed, the ability to formulate hypotheses is one of the highest marks of attainment of a scientific worker.

Of these fifty school men, three are directors or deans of colleges of education in universities; twelve instructors in education in universities or normal schools; seven presidents of normal schools; five directors of rural education in universities or normal schools; four directors of departments of agricultural education in colleges of agriculture; four presidents of universities; four superior instructors in high schools; two members of a board of regents of normal schools; one an instructor in a college of liberal arts; one a member of a state board of vocational education; one an assistant state commissioner of education; one a vice president of a college; one a former dean of an agricultural college; one a former president of an agricultural college; one a city superintendent; and in two cases names and positions were not reported. All of these educators are men and women of national proportions in ability and achievement in the educational field of the country.

A matter that is fundamental in planning a course in agriculture for a four-year high school, and likewise in a discussion of any industrial curriculum, is whether or not educational theory and practice warrant the use of industrial subjects or materials in a program of studies for the high school. Specifical-

ly, shall the high school of tomorrow conform to the traditional type of today—the general training idea—or shall it be characterized by practical elements, i. e., industrial, agricultural, or vocational? Forty-two of the fifty replies favored a combination of practical instruction with the general training idea. Twenty-one of these would require larger emphasis on the practical subjects than at present. Ten are very solicitous that the academic subjects be not neglected, and eleven simply suggest a wise combination of the two kinds of subject matter. Since many of the correspondents express various shades of opinion on the proposition of traditional versus practical instruction, rather liberal quotations from the answers will not be amiss.

Some of those who stress the practical instruction state their position as follows: 1. "The traditional idea will play a less and less important part as time goes on, but custom and locality will continue to be important factors for some time. The curriculum will be more and more practical. The great war is forcing us to it—at least, hastening the process." 2. "I believe we shall see many changes in the next ten to twenty years, working probably toward Davenport's idea in *Education for Efficiency*—however, the path will be rough and stormy. The high schools will meet more and more the vocational needs of the community, but will not neglect the cultural elements." 3. "It is very difficult to give a complete and satisfactory answer to the question whether the high school should be largely of the traditional or practical type. Whole volumes have already been written on the subject and there is still a wide difference of opinion. I am inclined to the opinion that the high school of the future will be more 'practical' than the high school of the past, but it will not be narrowly practical. The differentiations in courses in the future will not be merely occupational in character. The differentiations will be in terms of grades or levels of intellectuality. The traditions of the present will continue as they should."

The importance of academic instruction in addition to the industrial is shown in these quotations: 1. "The high school of tomorrow will be a combination of the two ideas. The general training idea will be assailed, battered, and condemned. Yet it will survive in many important features and will fuse with good ideas of the extreme practical people." 2. "The weakest spot in industrial education today is that the work is too technical and intensive, with no ulterior or higher motives, namely

the cultural or educational. Is there no difference between training and education, between mercenary and economic? I believe in the general training high school, but with some of the practical work grafted on; in other words, the general training high school modified, both root and graft." Seven of the correspondents give characterizations of the new high school that are different from any of the others that subscribe to the combination of general and practical instruction. Six of these believe that in this country various types of high schools should be established. Two quotations will give the point of view: 1. "In my judgment we shall have two types of high schools in this country. The dominating one will be largely the type of today, emphasizing in a general way vocational training. There will grow, however, in importance and influence, the vocational high school, which in the city will be industrial and in the country agricultural—both emphasizing home economics." 2. "We shall have differentiated high schools, literary, commercial, technical, and various types of junior high schools, including certain trade schools requiring much academic work." One of the seven replies stands in a class by itself. It is as follows: "If democracy wins the war (as it must ultimately) the demand will be for a much higher level of general culture. If the German ideas should still persist in the new order, we may look for our secondary schools to become highly vocationalized." Only one of the fifty scorns the idea of practical subjects or materials in the high school curriculum.

Evidently, the agreement is practically unanimous on the use of industrial materials for educational purposes in the high school. The difference of opinion seems to lie in the question as to the degree that this subject matter is to be used for general educational purposes, or for the development of knowledge and skill for direct participation in the industrial life of the nation. Undoubtedly, industrial subjects should serve both purposes. But if some of these educators hold exclusively to the first of these functions, the inevitable question that arises is, where in our educational institutions will we provide our American youths with the equipment that aids directly in the making of a livelihood, if not for themselves, then for those of the social fabric of which they are a part? The idea that the high schools are simply preparatory schools, or instruments exclusively for training for leisure, is antiquated, and ought not be resurrected. Surely, this war has impressed all genuine Americans with the

untenability of the conception that the function of our high schools is to develop a superior class of citizens who do the thinking for the nation, while others should be denied the stimulation of the intellect and feeling in broader aspects. In other words, some of the youth of our land should not be shunted from the elementary schools into a type of trade schools where they are given only narrow technical training. Such an idea has too much in common with the educational plan of the German autocracy, a system of education that has not been, until recently, set in its true light, and which with the advent of peace will lie broken at the feet of world democracy. The high school of tomorrow, as never before, should truly become the instrument of democracy. In harmony with this conception comes the declaration from a recent conference under the direction of Commissioner Claxton of the Bureau of Education. This conference declared that no subject matter should be accorded a place in the secondary schools unless it ministers to realization of one or more of these objectives: Health of the individual and of the community; command of fundamental processes; worthy home membership; citizenship in a democracy; worthy use of leisure; ethical character; vocational guidance and preparation.

A fair interpretation of the provision in this report for vocational guidance and preparation might not require students in the high school who are looking forward to the professions of law, ministry, medicine, and teaching to receive instruction in the industries—agriculture, manufacturing, mechanics, trades, transportation, or some form of domestic service. But such a plan would defeat one of the chief purposes of industrial training: namely, the development of a truly democratic citizenry. The demand of the hour is for men and women in sympathy with all phases of American life. Suppose that a student, after graduation from the high school, should decide to enter the profession of law, no argument should be necessary to show that such training in agriculture in the high school might be a more valuable asset in a life career than the benefit derived from an equal amount of time spent in pursuit of subjects more closely related to the profession of law. Lawyers, preachers, physicians, and teachers have as much need to be educated in the industries, as those who go into the industries to be schooled in the traditional type of education. The form of industrial work in a high school depends on the community. In the open

country and rural villages and cities agricultural instruction is imperative, while in the larger cities it should be instruction in harmony with its major industrial activities, or opportunities. Such a plan of education will tend to destroy, at the fountain head, the development of caste in American society, a condition inimical to American democracy.

After the discussion of this general aspect of a course in agriculture for a four-year high school, some of the more specific questions may receive attention. The fifty educators were asked to state the minimum number of units of English, mathematics, social science, biological science, and physical science in a four-year agricultural course, if a unit is interpreted to mean a subject pursued for one semester (one-half year) with one recitation daily. Only twenty-eight out of the fifty complied with the request. The median recommendation is English 5.2 units, mathematics 2.68 units, biological science 3.2 units, social science 3.9 units, and physical science 3 units. In addition, one correspondent suggests that two units of rural economics, and one and one-half units each of manual training, drawing, and music be required; and another would require one unit each of drawing and music. On this basis, in a four-year high school course with 32 units, practically 18 units would consist of required academic subjects, and the remaining 14 units could be devoted to required agricultural courses and electives.

One of the knotty problems for those who have attempted to formulate agriculture courses is the apportionment of time in the high school between the general and agricultural subjects. The median for thirty-three who offered an opinion is 61.1 per cent of the time for general training with a range from 40 per cent to 75 per cent of the time. The median of these same thirty-three is 34.9 per cent of the time for agricultural instruction, with a range from 25 per cent to 60 per cent. In view of this result, the natural wonder is where those who wrote the Smith-Hughes Bill obtained their data for the decision that one-half of the time of the high school should be allotted to agricultural instruction.

If greater attention is to be accorded to the traditional subjects, and less to the practical, the problem is still open as to the apportionment of emphasis between the science and art of the agricultural subjects. It was a surprise to discover in some of the replies a lack of appreciation of the difference between art and science of a subject. An appreciation, for instance,

that the chemical compound, monocalcium phosphate, results from the interaction of the decomposition products of barnyard manure and rock phosphate, and that monocalcium phosphate is more readily available to the roots of plants than the original rock phosphate are illustrations of a scientific knowledge.

A knowledge of the method of application of rock phosphate and manure in the proper proportions, and the method of application of these fertilizers to the soil, is art. The science gives the reasons "why," while the art teaches "how." Twenty-four give a numerical valuation with a median of 52 per cent for art, and 54.8 per cent for science. The range for art is from 10 per cent to 66 2-3 per cent, and for science from 33 1-3 per cent to 90 per cent. Some of the replies on the distribution of time between art and science are as follows: 1. "Depends on amount and character of previous experience of student in the art." 2. "Depends somewhat on course under consideration. I should want a large element of the latter (the art) in any case." 3. "It should be wholly a matter of the acquisition of the art and facts. The science should start with these facts as a basis." 4. "Fail to see the difference between the terms." 5. "For high schools the art side should predominate." 6. "Approximately half and half, with more time given to science, if students have not had nature study in the grades." 7. "An equal amount of time to each. The art may have to be learned out of school hours." 8. "Art enough to make it clear and concrete, and to acquire some effective controls, but mostly science of course." 9. "The Smith-Hughes Law says six months for practice. No one seems to know just what this means. The 50-50 plan of trades cannot be applied in agriculture."

A phase of this discussion of science versus art in agricultural instruction of peculiar interest to a group of teachers that constitute the membership of the Central Association of Science and Mathematics Teachers is whether the principles of science should be originally taught in the standard science courses as botany, zoology, physiology, physics, chemistry, general science, etc., or as a part of such agricultural courses as agronomy, animal husbandry, farm mechanics, farm management, etc. Twenty-one of the school men have convictions that the fundamentals of science are best learned in the standard sciences, and then special features of each science that are applicable again stressed in the agricultural courses. Five would abandon

the science courses, and teach the principles of science as the comprehension of the agricultural subject demands. Two subscribe to both of the options. Four suggest an interesting plan which may have much in its favor. They maintain that the principles of science should be developed in connection with the agricultural subjects, but in the last year of the course the principles of each science should be unified and organized, so that at the time of graduation the students may have a body of scientific generalizations. Some of the following statements are typical: 1. "The principles of the sciences should be presented in separated courses with such references to their applications to soils, crops, nutrition, etc., as may be practicable." 2. "Agriculture cannot be taught through the sciences, and the converse is also impossible. Supplementing each other is desirable." 3. "Even in agricultural courses not all the pupils are going to practice agriculture. If botany, physics, etc., are taught with a strong community significance, they will be helpful to all, and as valuable for those who are going to practice agriculture as will the most specialized courses. The specialized courses should rest on the others." 4. "As a part of the agricultural courses. (I doubt, however, if there will be any schools where this can be done strictly from an administrative standpoint.)" 5. "First as a part of the agricultural courses, and second as completion courses in the different sciences, the completion courses coming in the later years of the entire courses."

Very likely each of these positions as evidenced in these quotations has merit. In addition, in favor of the teaching of principles of science in the agricultural course, the strongest argument is that a strong motive, namely the need of the knowledge of the principle, is furnished. But on the other hand, in favor of keeping the basic sciences intact and not permit them to fuse with agricultural subjects, it seems psychologically correct to say that a time set apart for the mastery of principles and generalizations, and another for the consideration of their applications, is in the interest of economy of time and effective instruction. For instance, if a student in the subject of soils is to make the most rapid and unhampered progress, it ought not be necessary in a study of the relation of soil water to plant growth to suspend the main line of thinking to learn the meaning of capillarity. Much less educational waste will result if the student has been made acquainted with this princi-

ple, in a previous course in physics. This does not imply that agricultural materials should not be utilized for the mastery of principles. In fact, with students from the farm this is the only method, because through this practice the steps in the development of the principles are made meaningful.

If the function of an agricultural course, at least in part, is to train students in the skill of agriculture, the problem remains as to the best laboratory for this type of work. Several alternatives are possible: a school farm under the ownership and operation of the high school authorities; an arrangement by which students practice the art of agriculture on near-by farms; through projects on the home farm; on land or with animals leased or bought by the students; or a combination of any of these options. The state of Minnesota has experimented extensively with school farms. The experiences, in many instances, have been anything but satisfactory. The present tendency, especially in Massachusetts, New York, Minnesota, and Wisconsin is to push the "project idea." Some thinkers on agricultural education are so enthusiastic relative to "project work" that they give the impression that it is the *summum bonum* of agricultural education. In the state of Wisconsin, the State Department of Education does not grant state aid for agricultural instruction in the high school, unless every student in the course undertakes and completes a plant or animal project, according to a definite plan in each year that he pursues the agricultural course. Some of the projects listed in the *Wisconsin State Manual for Agriculture in the High School* are: 1. Growing an acre or less of corn. One acre is a standard area, but results on a smaller area may be figured out to the acre unit. 2. Developing a plot of alfalfa. 3. Selecting, curing, testing, grading, and selling of seed corn. 4. Raising tomatoes, beans, peas, or cucumbers for canning or pickling at home or factory. 5. Landscaping home or school grounds. 6. Pruning and spraying fruit. 7. Raising baby beef. 8. Keeping dairy record for two to five cows over a certain period, three, six, or nine months, and determining yearly profit. 9. Care and management of bees. 10. Calf raising or fattening; strict account kept, calf weighed regularly and exhibited at fair. 11. Working out life history, economic importance, and means of control of insects. Reports to the questions by the fifty educators: Do you favor the "project idea" in agricultural instruction? If you do, should projects be optional or required?

show that of the thirty-three that responded, thirty-one are favorable, one is opposed, and one noncommittal. Of those that endorse projects, twenty-seven would require them, and four would make projects optional. Some of the expressions on the subject are as follows: 1. "Some choice should be allowed within prescribed narrow limits." 2. "Required for those planning to enter upon an agricultural pursuit." 3. "Indeed, I do. As a rule it should be required, but the thing has not been properly worked out. A good deal of this agricultural work is in a sort of transitional stage. I hope that it will come to its own soon." 4. "Yes, as a method. Required, where possible or practicable." 5. "Yes, but don't work it to death." 6. "Yes, if we mean that projects are classified together under large unified topics, and the project itself is broken up into smaller problems." 7. "Yes, in all teaching."

On the advisability of students devoting a portion of school-time on a farm, if one is available, to gain proficiency in the practical affairs in agriculture, the opinion of the educators is about equally divided. A classification of thirty-seven answers shows that nineteen are of the opinion that students should have this training, five favor the idea unless the students are farm born and trained, three say that some time outside of school should be spent on the farm, and two think that project work is better. The rest of the thirty-seven answers are as follows: 1. "Not practicable unless the school is very small." 2. "Yes, but it should be on a well-managed farm." 3. "That would depend on the pupils and their previous experience. In all probability, I should make some use with any group of pupils." 4. "Spend summer vacation in actual farm labor." 5. "Only in summer season. School farm not advisable in most cases." 6. "Would connect up with real farming. Don't believe school farm feasible." 7. "Sounds good, but will not work on 50-50 plan with American boys. Home work is better for boys of secondary school age. I grant there are cases where it is desirable to have opportunity for farm work at school." 8. "Yes if it is properly 'followed up' and supervised. Local conditions have a great deal to do with this, but there is a growing demand for farm practice in some form. The agricultural colleges have it, and probably a system can be worked out for the agriculture in the high school."

Some additional difficulties that a maker of an agricultural course faces is the sequence of the agricultural courses with

reference to each other, and the semester and year of the academic course, particularly the standard science courses. The usual order of the agricultural subjects in the courses that are in operation are farm plant life the first year, animal husbandry the second year, soils and fertilizers the third, and farm mechanics and farm management the fourth. It is not easy to find any good argument why farm plant life should precede animal husbandry. The position of soils and fertilizers may be justified in the third year, on account of the greater difficulty of these subjects in comparison with plant and animal studies, and also that a study of soils and fertilizers is significant chiefly in relation to farm life and animal husbandry. Possibly the reason of greater intricacy and resultant demand of greater maturity of students for comprehension may be sufficient reason for farm mechanics and farm management in the fourth year. Some writers on a course in agriculture attempt to justify the usual order of agricultural subjects in the high school on the basis of the developing interest of students, but experience does not bear out such a contention. One of the subjects in the first semester in the first year that is occasionally listed is a course in general agriculture. Under certain conditions, such a plan seems good practice, especially if no systematic instruction in agriculture is attempted or effectively taught in the seventh and eighth grades. A course in general agriculture might give a bird's-eye view of the entire field. It might be a stimulus to arouse interest in agriculture and give students an appreciation of the vastness of the field. Many boys from farms are reluctant to undertake an agricultural course, because they remember only too well the hardships of the occupation, and upon entrance to the high school want an education, but not a continuance of the life of drudgery. A general course in agriculture with its variety of appeal is a better instrument than an intensive pursuit of some part of the subject to negative this illusion.

If the science courses are to furnish principles for application for the agricultural subjects, then each science course should precede, or at least be coordinate in time with, the industrial course to which it is contributory. The practical application of this philosophy meets with partial defeat on account of the close connection between all agricultural and science courses; that is, for instance, physics is basic not only in farm mechanics but also in farm plant life and soils and fertilizers. Likewise

chemistry is basic in farm plant life, animal studies, soils and fertilizers, and farm management. Botany furnishes the scientific principles for farm plant life. Physics, chemistry and botany are an impossibility in the first year of the course, unless the instruction is conducted only in the mere rudiments of these subjects. Possibly general science courses may be an assistance in the solution of the difficulty.

One other matter demands attention, and that is the content of the agricultural subjects. Is it good educational theory to devise a core of minimum requirements in the agricultural subjects, or is such a thought out of harmony with the purposes of agricultural instruction? Dr. Theodore H. Eaton, in an article in *School and Society* under the title, "A Possible Core for a Program in Agricultural Education," and Dr. David Snedden in a subsequent article in the same journal on the subject, "Agricultural Education—What Is It?" have discussed this proposition. Dr. Eaton advises technological study in the chemistry of plant and animal life, the physics and chemistry of soils, tillage, manuring, drainage, irrigation, plant and animal pathology and sanitation, economic entomology, feeding, and the implications that lead to botany, zoology, geology, and geography. Dr. Snedden takes issue with conception of the feasibility of a core of minimum essentials in agricultural instruction for all high schools. Some of the arguments that he advances are "that misdirected efforts will result in the effort to train boys (and men) to be farmers in the general sense —old theory of vocational education which would train all to be men, a right ideal of liberal, as distinguished from vocational education." "Liberal education," he says, "has little to do with vocations of tillage and stock raising. There is very little need of liberal agricultural education in rural communities. Only cities should require liberal agricultural education, or appreciation courses. We do not train dentists in the same way that we train lawyers, or journalists in the same way we train electrical engineers. We can not speak of training farmers in the general sense—some are of the greatest possible service by being successful poultry men; others through being successful growers of oranges; and still others, respectively, as market gardeners, as potato kings, as apple growers, as mule raisers, as growers of corn and hogs, as producers of milk. There is nothing in common between that which makes one boy a successful poultry man, and another a successful orange grower.

In each of these lines he needs to know as much about the principles of operation as he knows about the operation of a watch. As time goes on he will need to know less about principles because we are about to enter upon an age of fool proof machinery."

The fallacy of Dr. Snedden's contention is that in his thinking he carries the idea of the trade school into agricultural education. He seems to be a champion of the narrow artisan, conception of industrial training. In the first place, agriculture is not a trade, but as Dean Eugene Davenport in his *Education for Efficiency* declares, a mode of life. A mode of life that involves more than the operation of a machine in a factory, more than the farmer himself, but involves his entire family. In the second place, a great many more common elements are found in the different divisions of plant and animal production, operation of farm machinery, home and farm management, than the doctor grants. Finally, a young man with the general training in agriculture, with the successful completion of a number of projects that appeal to the interest of the student, and with practice on the school and home farm, receives the best sort of equipment that could be desired for him to succeed in any special line of agricultural activity that his judgment leads him to undertake. Dr. Snedden's scheme would make a mere automaton out of a farmer, with little power of adjustment for new tasks. If it meant greater efficiency in the art of agriculture it would be unwise in the interest of the farmer's individual welfare and that of the nation.

A definite formulation of a course in agriculture in harmony with the recommendations of the fifty educators and the discussions does not seem advisable. Any one who is interested in this feature, and who grants the validity of the conclusions, can devise a course with greater satisfaction to himself than would result from an outline handed to him, complete in its details.

Since this paper has dealt with a rather large variety of features of a course in agriculture for a four-year high school, a summary of the possible conclusions seems appropriate, to prevent the loss of the good grain in the chaff. 1. Of the fifty educators who gave an opinion on the type of high school for tomorrow—traditional versus practical—the verdict is essentially unanimous in favor of both kinds of subject matter. The difference in the judgments is as to whether the instruction in practical materials shall be for the enrichment of the academic

subjects, for direct participation in industries, or for both. 2. The median of recommendations of twenty-eight educators for required work in English is 5.2 units, mathematics 2.68 units, biological science 3.24 units, social science 3.9 units, physical science 3 units, with individual suggestions that music, rural economics, manual training, and drawing be required. The total of required academic subjects is about 18 units of the 32 in a four-year high school course. 3. On the question of the distribution of time between general and agricultural subjects, the median for thirty-three correspondents who offered an opinion is 61 per cent of the time of the high school for general training, and 34.9 per cent of the time for agricultural instruction. 4. A study of the replies of twenty-four of the school men shows a median of 52 per cent of the time for art of agriculture, and 54.8 per cent of the time for science; in other words, about an equal division of time between the "how" and "why" of agriculture. 5. Twenty-one of the school men desire that the fundamentals of science be learned in the agricultural courses. Five favor the abandonment of the science courses, and teaching the principles required in connection with the agricultural subjects. Two of the correspondents would do both. Four suggest the development of the principles in the agricultural courses, but demand a unification of these principles before graduation from high school, to furnish a body of scientific generalizations. 6. The skills of agricultural practice can be obtained on a school farm owned by the school, a nearby farm, through projects on the home farm, or on land leased or animals bought by students. Of thirty-three reports that were received, twenty-seven are for required projects, four optional, one not required, and one non-committal. 7. On the advisability of students spending a portion of school-time on a farm, the opinion is about equally divided. 8. The usual order of agricultural subjects in the course is plant studies the first year, animal studies the second year, soils and fertilizers the third year, and farm mechanics and management the fourth year. 9. A satisfactory arrangement of the general subjects, particularly the science courses, is one of the unsolved problems, if the principles of science should be taught in courses more or less separate from the agricultural courses. 10. The content of the agricultural courses is under vigorous consideration at the present time, under the stimulation of the Smith-Hughes legislation, which is interpreted by some to mean a protest against the present materials in the agricultural subjects.

A RANGE OF INFORMATION TEST IN SCIENCE.

By Elliot R. Downing,
University of Chicago.

The time has come, it seems to me, when this Biology Section of the Central Association that is seriously concerned with the problems of education should cease to convene merely for discussion, and address itself to these problems in accordance with that scientific spirit for which, supposedly, we stand. In days not so very far distant biologists were wont to *discuss* such an unsettled point as to whether or no living things might arise by spontaneous generation. Pasteur settled that not by skill in debate, but by skilful and conclusive experiment. We all know how unfruitful in scientific results was that prolonged period of *discussion* following the publication of Darwin's *Origin of Species* and his *Descent of Man.* It was not until polemics ceased and *experimental investigations* began again, that our knowledge of evolutionary processes was once more increased.

I do not mean to imply that the former programs of our section have been without papers that presented scientific studies of the pedagogy of science; far from it. There have been occasionally excellent studies made whose results have first been announced here, but I do mean that this section has not yet consciously and steadfastly set itself to a scientific study of the problems of biological teaching.

Three major lines of investigation are immediately needed. 1. A careful *survey* of the schools in our Association to determine what are the present standards in biology instruction regarding aims attempted, principles that are stressed, materials that are used, and methods that are in vogue, to the end that we may have definite, accepted standards of efficiency. 2. *Experimentation* to settle such disputed questions of methods and materials as can only be so settled. 3. *Standardized tests* that may be given to see if we are accomplishing what we set out to do.

I. The Survey. I conceive it would be a tremendously helpful thing to the biology teachers in our territory if this section could publish, in concise form, such information as would result from a careful survey of the facts as they exist. Suppose for instance we could say:

As the result of a survey of the schools of the Central Association it has been found:

(*a*) That the important things to come out of biology in-

struction are as follows, stated in order of their importance as determined by the expressed opinion of the teachers.

(*b*) That the following are the concepts or principles or topics of biology that need most emphasis as determined by present practices.

(*c*) That the texts in botany, biology, physiology, and zoology in widest use in our territory are as follows, giving in addition to the names the percentage of schools in this territory in which each is used. Analyses of all the widely used texts would enable teachers to see at a glance their relative merits for a particular use.

(*d*) That the mean percentage of time spent on each of the animal or plant groups or on each of the important biological topics is as follows:

The mean percentage of time given to recitation is..............; laboratory work....................; to field work ....; to work with the compound microscope....................; etc.

This merely begins to suggest the things we want to know, to give us any adequate idea of what the present standards are in biology instruction in our territory. Some of the items are in part available now. But the articles in which this information occurs are widely scattered in point of time, and I imagine few if any of us could give a new teacher all the information I have suggested as immensely helpful in formulating her work, or could apply it to ourselves in judging our own work.

II. Experimentation. There are many questions of methods and materials to be used that can only be settled by experiment. Take, for instance, one suggested by Mr. Slimn in his topics of discussion on his paper, "The High Schools of Tomorrow." "Would a change in method from the pure quiz recitation to that of demonstration and supervised study increase efficiency of work?" The answer is to be found by experiment, not by discussion. As well discuss the question, "Is close inbreeding detrimental to stock?" We have learned as biologists that the way to settle such a question is by trying it out repeatedly and keeping accurate record of results. Why not attack our questions in methodology of science instruction in the same scientific way? I know it will take a long time to get conclusive evidence on all the unsettled points. But we shall be making progress in the only way it can be made; when a problem is so settled scientifically, it is solved for good, and we shall not have to meet annually to thrash over the same question and go away none the wiser for our time and effort.

III. TESTS. Having set ourselves definite goals we must devise tests to see if we are achieving such, and I approach now the particular thing in which I want to report a slight contribution.

Please put an E beside words and phrases (on the list below) that you can explain or define; an F beside those you have heard or read about, the meaning of which is not clear; and an N beside those that are new. Explain or define the first three you mark with an E.

1. Action and reaction are equal.
2. Adaptation.
3. Alpine flora.
4. Angle of reflection.
5. Animal society.
6. Atom.
7. Avogadro's Law.
8. Battery pole.
9. Buoyancy.
10. Candle power.
11. Center of gravity.
12. Comet.
13. Commensalism.
14. Composition of forces.
15. Conduction.
16. Conservation of energy.
17. Dew point.
18. Differentiation of tissues.
19. Disease organisms.
20. Drowned valley.
21. Eclipse.
22. Egg.
23. Electrical resistance.
24. Electromagnet.
25. Enzyme.
26. Erosion.
27. Equinox.
28. Evolution.
29. Family tree.
30. Fertility of soil.
31. Fertilization of egg.
32. Food plain.
33. Fossil.
34. Gas diffusion.
35. Germ plasm.
36. Heat expansion.
37. Ionization.
38. Isomer.
39. Induced currents.
40. Inertia.
41. Inoculation.
42. Instinct.
43. Law of definite proportion.
44. Law of gravitation.
45. Law of the lever.
46. Law of the pulley.
47. Laws of fluid pressure.
48. Lines of magnetic force.
49. Mature topography.
50. Mendel's law of heredity.
51. Metabolism.
52. Metamorphic rock.
53. Migration.
54. Mimicry.
55. Molecule.
56. Momentum.
57. Moraine.
58. Mutation.
59. Natural selection.
60. Nebula.
61. Neap tide.
62. Nitrifying bacteria.
63. Noncomformity of rock strata.
64. Non-inheritance of acquired characters.
65. Normal curve of variation.
66. Orbit of the moon.
67. Osmosis.
68. Oxidation.
69. Photosynthesis.
70. Parasitism.
71. Planetesimal hypothesis.
72. Plant or animal cell.
73. Polarized light.
74. Precession of the equinoxes.
75. Precipitate.
76. Pure line.
77. Refraction of light.
78. Regeneration of parts.
79. Relation of frequency to pitch.
80. Reversion.
81. Saturation.
82. Sedimentation.
83. Solar system.
84. Specialization of function.
85. Specific heat.
86. Spectroscopic analysis.
87. Spontaneous generation.
88. Stable equilibrium.
89. Star.
90. Sterilization.
91. Subatomic energy.
92. Surface tension.
93. Symbiosis.
94. Synthetic sugar.
95. The ice age.
96. Toxin.

97. Tropism.	Male or female
98. Valence.	Grade.......................7, 8, 9 or 10
99. Variation.	College year.................7, 8, 9 or 10
100. Vertebrate type.	College graduate...........7, 8, 9 or 10

There are a number of worth-while aims in science teaching—the achievement of certain skills, attitudes of mind, tastes, ideals, etc. Probably we would all agree, too, that some knowledge should be acquired, and the more this can be carried away by the pupil in the form of generalizations rather than as masses of unrelated fact, the more likely it is to function in his later life.

I have, therefore, devised a range of information test in science that deals with such general notions, and have been trying it out on pupils to see what percentage of these ideas are clear at various levels in our school system. I shall confine myself now to a preliminary report on the results with high school freshmen and college freshmen and sophomores.

To make up the list of one hundred words and phrases that suggest important generalizations that, it would seem, our science education should make meaningful, I went through a number of secondary texts in astronomy, biology, botany, general science, geography, physics, physiography, physiology, and zoology, and selected those that were stressed most frequently and thoroughly. I then submitted my tentative list to a number of high school teachers of such subjects, asking them to indicate what ones in their opinion should be stricken out as relatively unimportant, and to suggest any important ones I had omitted. I revised my list then in accordance with the opinions of the majority. The list follows, together with instructions for making the same.

This test has now been given or is being given to seventh- and eighth-grade pupils, high school freshmen, sophomores, juniors, seniors, college freshmen, and sophomores—some fifteen hundred in all. The resulting papers are being studied with a view to tabulating the results. The high schools which have submitted to these tests are two in Chicago, one in Illinois outside of Chicago, one each in Wisconsin and Michigan. College students have been tested in institutions in the same states and also in Missouri.

It is to be noted that in the directions for the test not only are pupils requested to mark with an E the terms they can explain or define, but they are asked to define or explain the first three so marked. This gives a check on the accuracy of the pupil's own estimate of his ability to satisfactorily explain or define

the terms he marks with an E. These definitions have been looked over, and if unsatisfactory, the pupil evidently not understanding the terms he undertakes to define, his estimate of his ability is scaled down accordingly. If, for instance, a pupil marks twenty-one terms with an E, and one of his definitions shows he has the wrong conception entirely, seven of his E's are transferred to the F's. The estimates of high school pupils, it is found, must be thus scaled down on the average one-third. On the other hand, the college students' estimates of their own ability need practically no alteration.

There follow the data, thus revised, from the two Chicago high schools and from college freshmen and sophmores at DeKalb.

108 U. High freshmen	Average 18 words marked E	30.4F	51.6N
112 Fenger Hgh. freshm'n	Average 21.5 words marked E.	17.1F	61.4N
141 DeKalb Col. freshm'n	Average 34.6 words marked E.	30 F	35.4N
83 DeKalb Col. soph's	Average 44.7 words marked E.	32.7F	22.6N

From this tabulation it is evident that there is a rise in the percentage of words marked E by high school freshmen, college freshmen, and sophomores, that is quite consistent with the level of these three groups. If additional tests verify the results so far achieved, one might give the test to the freshmen of any high school and feel assured that if they achieve close to twenty per cent of E's they are an average lot as far as science training is concerned, but if they fall much below this grade or get much above it they are respectively an inferior or a superior group in this one particular.

The results of the test already show that there is great variation in the scientific attainments of the pupils in the freshmen group, or in other words the apperceptive mass measured in terms of scientific general concepts is a very variable quantity. Thus one U. High freshman marks fifty-nine out of the hundred terms with E, and requires no scaling down, while several mark none E.

Per Cent of High School Freshmen. Fenger H. S.	Univ. H. S.	Per Cent of College Freshmen.	Who Marked.
		.7	80-89 words E
		1.4	70-79 words E
		5.	60-69 words E
1.8	.9	10.	50-59 words E
2.7	3.7	20.5	40-48 words E
11.6	7.4	26.2	30-39 words E
16.8	26.9	21.9	20-29 words E
37.6	42.6	12.9	10-19 words E
29.5	18.5	1.4	0-9 words E

The above table shows the percentage of the high

school freshmen in the two schools (U. High and Fenger), and the percentage of the college freshmen that have marked the stated number of words with an E.

This discloses one of the great difficulties all science teachers have felt, but a difficulty we have never been able to express so clearly in figures; namely, that pupils in science classes are very inadequately graded as far as their scientific achievements and abilities are concerned. High school pupils are promoted or demoted on the basis of ability in English, mathematics, Latin perhaps, but scientific achievements or the lack of the same is ignored. Moreover, the administrative officer has often not recognized that there is a sequence in the science courses, but has put freshmen students into junior science, or vice versa. The results tabulated above from the range of information test will make apparent to the administrator who comprehends tests better than he does science, the unfairness of any scheme which brings together into one class such a heterogeneous assortment of abilities as is here disclosed.

But can the test be modified so as to be more easily given and scored, and still be as effective? Apparently fifty terms will give as good results as the one hundred. For if we consider the percentage of students who have marked each term, we find the following number of words have been marked E:

In the High School. Fenger.	U. High.	In the College.	
0	1	5	By 80-90 per cent of the pupils
1	7	7	By 70-80 per cent of the pupils
7	4	14	By 60-70 per cent of the pupils
7	5	11	By 50-60 per cent of the pupils
10	5	10	By 40-50 per cent of the pupils
6	9	7	By 30-40 per cent of the pupils
6	14	17	By 20-30 per cent of the pupils
18	18	15	By 10-20 per cent of the pupils
45	37	14	By 0-10 per cent of the pupils
100	100	100	

The task that will be undertaken immediately is the abbreviation of the list, provided the returns now coming continue to show what those now reported seem to indicate. I trust when the simplified list is ready I may have your cooperation in giving it wide trial. I further hope that this contribution, insignificant as it is as compared with the vast range of problems in the pedagogy of science, will stimulate the members of this section to plan a systematic attack on these problems in a real scientific way.

THE BOTANICAL WORK OF THE NATIONAL RESEARCH COUNCIL.

By Dr. John M. Coulter,
University of Chicago.

(*Abstract.*)

In the short time at my disposal it will be impossible to go into details regarding the work of this Council. My purpose will be to develop perspective.

About a year before we entered the war, President Wilson asked the National Academy of Science to appoint a National Research Council. The original purpose of the National Research Council was to form a federation of institutions, in order, first, to stimulate fundamental research, second, to secure co-operation among these institutions and among investigators, and, third, to secure aid.

The work of the National Research Council falls naturally into three periods—the period before the war, the period during the war, and the period of reconstruction. During the one year of the period before the war, two things were attempted—first to take a census of investigators and the problems under way, and, second, to take a census of equipment for research. As a result of this investigation, a good physiologist was found without any equipment, while in another institution, a fine equipment was found but no physiologist. These lines of work were just nicely started when the war interrupted.

The war period was characterized by a large number of emergency problems. Many of these were not problems at all. Some called merely for information, while others called for immediate action. These problems came in so fast that a re-organization of the National Council was imperative. An executive committee was formed to examine and distribute the problems in order to get speedy action. This committee met once each week in Washington.

The emergency problems may be grouped into three categories, as follows: food, timber, and raw products. There was no time to solve these problems. The only thing to be done was to pool our knowledge and act accordingly. Four problems presented themselves at once. They were the problem of adjustment, the problem of drought resistance and the problem of soil management. To deal with these problems, it was necessary to call upon the plant physiologist and upon the plant ecologist. The results of these investigations were organized and sent to

the Department of Agriculture in Washington, and this department, through its vast machinery and organization, handed them down to the manufacturer or producer who could use such information.

One aspect of the food problem was food production. A survey on plant diseases was now obviously needed. The plant pathologists did some fine work here. Various campaigns, such as that for barberry extermination, were carried on. Incidentally, many new facts relative to plant diseases were discovered.

Another aspect of the food problem was that of rationing the army. The problem here was not a question of proteins, carbohydrates, and fats, but a question of vitamin content. Much to our surprise, the lowly soy bean came into its own, standing at the head of the list in vitamin content. The peanut ranked second.

In the second category of emergency problems was the timber situation. We, of course, have plenty of airplane timber, but the difficulty came in the proper selecting and testing. Not a few of the airplane accidents were due to faulty timber which the forester could not detect. It remained for the trained scientist to discover the slightly diseased and weakened wood. The Council of Research worked in cooperation with the forest service, and the infusion of science into the latter stimulated and will continue to stimulate it to greater usefulness.

In the third category was the question of raw products. This division was so important that a Raw Products Committee was named. The war created a demand for raw materials which we either did not use before or could not at this time import. When any raw material was called for three questions immediately presented themselves. Does the needed plant grow here? If not, does any relative of the plant grow here? If so, can any part be used as a substitute? Some of the discoveries made were saponin, as a source of soap, sweet gum to be used in surgical dressings, sources for red dyes, and sources for drugs. The chief great value of the work of this committee was a development of our knowledge of our resources of raw products in the United States.

The third, or reconstruction, period is of course, just beginning. There will be a reorganization of the Council on December 6. One of the problems which the National Research Council expects to take up is a great cooperative problem involving

twenty laboratories. They will seek the relation of different combinations of various salts in the propagation of plants. These plants will be subjected to these experiments from the germination stage on through to maturity. Carried to successful conclusion, these experiments will affect vitally the problems of fertilizing soils and of increasing plant production generally. The National Research Council will also keep for investigators, current information available on research problems.

Four permanent results will grow out of the work of the National Research Council. First, scientific men will learn to know one another. Second, scientific men will learn to know practical men. Third, we shall all learn that science is a great national asset. Fourth, our schools will come more and more, to give courses which will make active contact between science and practice.

MINUTES OF THE BIOLOGY SECTION.

The meeting of Friday afternoon was called to order by the Chairman, Mr. Jerome Isenbarger of Senn High School, Chicago, the general topic for discussion being the demands an awakened democracy is making for effective teaching of the subjects of biology and agriculture. In the absence of the Secretary, Mr. C. H. Sackett, Ben Blewett Junior High School, St. Louis, Mo., the Chair appointed Mr. C. P. Shideler, Joliet, Ill., Secretary protem.

In a few introductory remarks the Chairman stated that the Biology Section as it is constituted at the present time includes the group of teachers who formerly made up the section, together with those who were included in the Agriculture Section. Attention was called to the splendid showing made by the Advertising Committee of the Association during the past year, and it was suggested that members of the section could lighten the burden of the Advertising Committee very materially by mentioning the Association when writing to advertisers whose advertisements appear in the program. A Nominating Committee was appointed with Mr. Worallo Whitney, Hyde Park High School, Chicago, as Chairman.

Dr. Will Scott of the University of Indiana read a paper on "The Function of Zoology in the Curriculum of the Modern Secondary School." Dr. Scott stated that a teacher of zoology should have not only a broad academic training, but also common sense and skill in organizing and presenting subject matter. "That zoology is in disrepute in the high schools is due largely to the fact that about twenty-five years ago many teachers undertook the subject who had neither qualification."

The speaker held that zoology is more difficult than either physics or chemistry, and quoted Dr. Millikan in a statement of the opinion that physics should be taught in the ninth year, preceding biology. The tendency to attain quickly and early in the course the so-called practical was spoken of as pernicious. "A boy may be taught a trade, but that very thing by its immediate return, may prevent him from becoming an engineer." Dr. Scott holds that morphology, together with a study of the principles of living matter and the laws that govern it, must be primary in any biological study as a basis for the purely practical.

"A Course in Agriculture for a Four-Year High School" was the subject of a paper by Mr. Fred T. Ullrich, State Normal School, Platteville, Wis. The author stated that the paper represented, in the main, the results of a collation of judgments of fifty leading educators, the data having been gathered by the questionnaire method.

1. Of the fifty educators who gave an opinion on the type of high school for tomorrow, traditional versus practical, the verdict is practically unanimous in favor of both kinds of subject matter.

2. The median of recommendations of twenty-eight educators for required work in English is 5.2 units, mathematics 2.68 units, biological sciences 3.24 units, social science 3.9, physical science 3 units. The total required academic subjects is about 18 units of the 32 in a four-year high school course.

3. On the question of the distribution of time between general and agricultural subjects, the median for thirty-three correspondents who offered an opinion is 61 per cent of the time of the high school for general training, and 34.9 per cent of the time for agricultural instruction.

4. A study of the replies of twenty-four of the school men shows a median of 52 per cent of the time for art of agriculture, and 54.8 per cent of the time for science of agriculture.

5. Twenty-one of the school men desire that the fundamentals of science be learned in the agricultural courses. Four suggest the development of the principles in the agricultural courses, but demand a unification of these principles before graduation from high school, to furnish a body of generalizations.

6. The skills of agricultural practice can be obtained on a school farm owned by the school, on a near-by farm, through projects on the home farm, or on land leased or with animals bought by the students. Of thirty-three reports, twenty-seven are for required projects.

7. On the advisability of students spending a portion of school time on a farm, the opinion is about equally divided.

8. The usual order of agricultural subjects in the course is plant studies the first year, animal studies the second year, soils and fertilizers the third, and farm mechanics and management the fourth.

9. Satisfactory arrangement of the general courses is an unsolved problem.

10. Content of agricultural courses is under vigorous consideration under stimulation of the Smith-Hughes legislation.

Dr. Elliot R. Downing, School of Education, University of Chicago, read a paper on "The Results of Science Instruction in Secondary Schools." The writer has used various tests, but chiefly those of the vocabulary type, to determine in a manner, the scientific attainments of pupils in different grades. The paper embodied the results of these investigations. Some questions which these and similar tests will aid in answering are as follows: What facts of science are particularly suited for any stated period of the school course? What subject matter had better be left out of the course at any particular time? Which are more effective at any particular period in the course, explanations with demonstrations, or laboratory methods? The work is a step in the direction of determination of organization and subject matter upon some dependable basis, work which is extremely practical if we are to fit the science courses to the peculiar inclinations and needs of our pupils.

Representing the General Committee on the High School of Tomorrow, Mr. Harold B. Shinn, Schurz High School, Chicago, reported to the section in an informal manner on "Biology and Agriculture in the High School of Tomorrow." Mr. Shinn stated that his report had been

read at last year's meeting at Columbus, and since that time no further work had been done on it. The fact was commented on as significant that, at the Urbana conference one week before, botany and zoology were running a losing race. A committee was even appointed to report next year on a suggested two-year course in general science. "If the community does not want our subject, we must adjust our courses. We must give the community what it wants and what it needs."

Mr. Shinn quoted from Secondary School Circular, No. 3, September, 1918—*Science Teaching in Secondary Schools in the War Emergency*. The first part of this Government circular is given over to a general statement of the problem, while the last part consists largely of courses in general science. The following suggestions are typical—that teachers should teach courses and facts which will enable pupils to serve as assistants to physicians, surgeons, sanitary officers, nurses, etc., that teachers should work at related trades during the summer. The opinion was expressed that to follow these suggestions would be bad from every point of view. To do so would make trade schools of our high schools.

In discussing the question, what punishment or pressure can be exerted upon the shiftless repeater and what recognition and allowance extended the bright pupil, Mr. Dudley Grant Hays of the Extension Department, Chicago Board of Education, suggested a reclassification of pupils, and placing these repeaters under a child study man.

Mr. Shinn referred to the Springfield plan, according to which each pupil classifies himself as to the grade of work he can do, and is given the work for that group.

Miss Nettie M. Cook of Springfield objected to the word, "punishment," used in this connection. "Our plan," she said, "is to find some point of contact with the students and get them interested in raising their grades." The pupils work in groups on problems designed for those particular groups. Miss Cook explained what she termed the socialized recitation which consists very largely of questions and answers by the students themselves, and of conferences between students and teacher.

It was expressed as the sense of the Biology Section that something should be done along the line of working out by tests and experiments some of the problems suggested by Dr. Downing. Accordingly, Mr. Shinn suggested that Dr. Downing state what he thought might be done. Dr. Downing explained what might be attempted by the Biology Section, and then made a motion that a committee be appointed to guide some lines of investigation covering problems in biology teaching. This motion was seconded, and it was passed by a vote of the section. The Chairman appointed Dr. Downing Chairman of this committee, but withheld appointment of other members.

SATURDAY MORNING 10 A. M.

The Nominating Committee, Worallo Whitney, Chairman, reported as follows:

For Chairman—Clarence L. Holtzman, Waller High School, Chicago.

For Vice Chairman—Miss Mabel E. Smallwood, Lane Technical High School, Chicago.

For Secretary—William E. Howard, Township High School, Ottawa, Ill.

A motion was made and carried to concur in this report of the Nominating Committee.

The first speaker was Dr. John M. Coulter, who spoke of the "Botanical Work of the National Research Council." (See abstract on page 234.)

The program was given over to a discussion of methods for vitalizing our courses in biology and agriculture.

In line with this diversion, Mrs. Nell J. Sanders, Calumet High School, read a paper on "Individual Projects in Biology and Agriculture." Mrs. Sanders has named her system for checking up the individual projects the "Unit System." Units of credit are offered for outside work. This work may be at home, in the field, in school, but it is on some problem in which the pupil is interested. The pupil becomes an investigator in his own chosen field. A certain number of units of credit for this outside work is required of all students. A "major" project and any combination of "minor" projects may be selected to make up the required number of units.

Following along the same line was an address by Mr. Clarence L. Holtzman, Waller High School, Chicago, on the "Practical Value and Methods of Bird Study in the High School." The subject was divided into four phases—habit, economic, taxonomic, and aesthetic. Each phase of the study was fully justified by descriptions of methods and results. Illustrative material was exhibited. Birds mounted in boxes may be handled indefinitely by pupils without injury to the specimens.

Interest in field work is stimulated by contests. A bird calendar lists the birds as they are reported, with the name of the pupil who first reports the bird. A bird "ladder" shows names of pupils with number of birds correctly identified opposite each name, the name with the highest number at the top of the "ladder." Essentially the same plan is carried out with the flowers.

Mr. Ralph E. Wager, Northern Illinois State Normal School, whose subject was the "Use of Illustrative Material in Biology and Agriculture," illustrated by means of stereopticon views, methods of photographing animals in the field and transferring these photographs to stereopticon slides. The members of the section showed their appreciation by extending to Mr. Wager a vote of thanks.

The section adjourned at 12:40.

C. P. Shideler,
Secretary pro tem.

MINUTES OF THE EARTH SCIENCE SECTION.

Due to the omission of the first number on the program, "The Significance of Geography as a High School Science," on account of the sickness of Mr. John Calvin Hanna, the meeting of the Earth Science Section was begun by the presentation of a committee report prepared by Mr. James H. Smith of the Austin High School, Chicago, on "Earth Science Courses in the Reorganized High School." Due to the absence of Mr. Smith, the report was read by Mr. W. F. Headley, Austin High School, Acting Secretary of the section.

At the first meeting of the committee were Dr. J. Paul Goode, Prof. D. C. Ridgley, and Mr. James H. Smith, Chairman, who critically discussed the present condition of geography in our schools and the demands of the times which call for systematic instruction on the countries and peoples of the world.

The committee recommended a course of four years of geography above the sixth grade, as follows:

Seventh grade: Continue geography of the sixth grade, using books now used.

Eighth grade: World geography.

Ninth or ten grades: Economic geography.

Eleventh or twelfth grade: Commercial countries.

Dr. Goode was most earnestly requested to undertake the preparation of books to meet the need of the last three grades mentioned.

At a second meeting of the committee, Miss Mabel C. Stark, Mr. John Calvin Hanna, and Dr. Wellington D. Jones contributed to the discussion. Dr. Goode reported that in collaboration with Dr. Chas. C. Colby and Dr. Wellington D. Jones, he was proceeding to carry out the desire of the committee as expressed at its first meeting.

Outlines of three unit courses in geography for high schools were given in detail, discussed at length, and constructively criticized. The three unit courses were next considered in order.

Unit I—"Elements of Geography." This unit was presented by Miss Mary Dopp, Parker High School, Chicago. The purpose as given is to study the relation of physical environment to life—clear-cut types of environment to be used. The approach is to be made through the avenue of human interest—the people, their habits, customs, and work being followed by the physical influence limiting them, as location, land, relief, climate, plant and animal life, soils, etc. The cotton belt, Egypt, Switzerland, and Norway are typical of the regions to be studied.

Unit II—"Economic Geography," was discussed by Dr. J. Paul Goode. The purpose of this unit is to get the influence of physical environment upon man in making his living. The method proposed is to study typical commodities of commerce and the movement of these in the flow of commerce. Dr. Goode dwelt at length on the products of the forest, farm, and orchard, of grazing lands, mines, and of hunting and fishing. His suggestions as to use of maps, graphs, pictures, and supplementary reading were particularly good.

Unit III—"Commercial Countries," was presented by Dr. Wellington D. Jones, University of Chicago. The desirability of this unit was emphasized. He lamented the fact that we lack maps suitable to show climate, rainfall, etc., something that will appeal to the eye. Japan was used as a typical country to study.

Some of the points to be developed are the physical geography of the country—topography, natural divisions, minerals, etc., the more important human responses—agriculture, mining, manufacturing; trade and trade routes of the country; relations of the country with others with reference to trade, territorial expansion, war, etc.

Dr. Jones recommended that each student should have: (1) Text: Smith, J. R. *Commerce and Industry*, (2) Atlas: Bartholomew's *Comparative*, (3) *Graphic Summary of World Agriculture*, Superintendent of Documents, Washington, D. C.; (4) *Graphic Summary of American Agriculture*, Superintendent of Documents, Washington, D. C. The classroom should be supplied with Philip's wall maps, showing summer and winter conditions for each continent, also world thermal maps and Goode's relief maps for each continent. It was suggested that, of the three units of geography to be given in the junior-senior high school, the first be given the first year, Unit II the second year, and Unit III the fourth year—each unit to be at least a half year's work.

The discussion of the high school course was led by Prof. Lucius T. Gould, Milwaukee Normal School. He said the following principles should control organization of work in geography:

1. Formulated with reference to the whole school curriculum and the work of the grades.
2. Keep function at foreground.
3. A culminating series of problems stated and printed as such.
4. Studied with reference to social importance.
5. Sequence of topics should follow the needs and capacities of students.
6. The course should be a growth.
7. Thorough treatment of a few topics only.

8. Curriculum evolved through conference of teachers.

Professors Goode and Whitbeck and the Misses Watson and Stark furthered the discussion. It developed that, since we think and read mostly of England, France, Germany, Japan, Canada, and the United States, these should be among the countries studied.

Saturday morning came a treat from Prof. R. H. Whitlock, Department of Geography, University of Wisconsin. He discussed the subject, "Our Country's Call for Geography Today and Tomorrow." He showed conclusively that the study of geography is indispensable. He showed the present need of geographers and geographic information, not only in Governmental affairs, but also as a means contributing to citizenship.

In the Government's urgent demand for geographers and geographic information at the beginning of the world war, it was found that we were deficient in both. In its need of world maps pertaining to timber, iron, coal, trade routes, etc., the Government called to Washington hundreds of geographers, who filled a city block and worked long hours at intensive study to supply the Government's needs. Urgent demands came to this body for immediate solution of numerous geographic problems. No one interested in what subjects should be taught in the high schools of our country can afford to fail to read Prof. Whitbeck's most excellently illuminating paper.

The last discussion of the meeting was on "The Operation of Geographic Factors in the Great War from the Viewpoint of a Student of History." Prof. Edward C. Page, State Normal School, DeKalb, Ill., said that map interpretation is neglected in our high schools. History and geography should be correlated. Historic information without a geographic setting is all "up in the air"—is meaningless. He showed the significance of the Appalachian system and the arid region in connection with the Civil War. Germany could not attack France except along the coastal plain of France and Belgium. Students of history know nothing of the forests of a country, and consider immigration and defensive and offensive in war as having no obstacles. Swamps, rivers, canals, valleys, etc., are not negligible factors of war. Had not Britain ruled the wave, Anglo-Saxon civilization would have been a very different story. Climatic regions and times of harvest in different parts of the earth were shown to be great historic factors. Racial geography caused the world war. History can be understood only in its geographic connection.

Miss Mabel Stark, Chairman of the Earth Science Section, named Messrs. J. M. Large and Charles S. Winslow and Miss Marion Sykes, as a Nominating Committee, resulting in the election of the following officers for the ensuing year:

Chairman—Mr. W. F. Headley, Austin High School, Chicago.

Vice-Chairman—Dr. Wellington D. Jones, University of Chicago.

Secretary—Miss Alberta Drew, Joliet Township High School.

It was moved, seconded, and carried unanimously that the section name be changed from Earth Science to Geography.

W. F. HEADLEY,
Acting Secretary.

GENERAL SCIENCE FROM A PRINCIPAL'S VIEWPOINT.

By R. G. Beals,
High School, Taylorville, Ill.

Since the birth of science courses in high schools we have been having science discussions from the view-point of the science professor and the college entrance examining board. Recently the professor of education has taken a hand in the discussion and has driven a wedge of doubt into the firm foundation of our science instructional system.

The voice of the high school principal has been little heard in the land because as an artisan he has been busily engaged in carrying out the plans of the constituted authorities in curriculum making. He was first bound to qualify as a skilled workman under existing conditions before being allowed a hand in the modification of those conditions, and even then his was a practical rather than a theoretical point of view.

The raw material of the science professor is the sum total of the laws, principles, and facts of his particular science. His task is their organization and application. His interest centers in a rigidly logical, and we might say a somewhat ossified, group of closely related and often joy-excluding facts and principles.

The raw material of the high school principal is the pupil himself in action, his tendencies, interests, antipathies, and motives, his home, his surroundings, his future. The principal's task is to advance the pupil, together with his group, into the fullest possible participation in the life interest, problems, and responsibilities of his fellowmen.

The scientist who develops the great physical and biological sciences, and the principal who develops the pupil in his relation to these sciences, are coworkers, each with his field and his limitations. The one deals with an organized subject, the product of mature minds and suitable to relatively mature individuals. The one deals with a logical process of scientific facts properly shorn of adventitious elements. The other leads the pupil into the thousand and one rooms of the magic palace that suddenly springs up all around him. He deals with immaturity for the development of immaturity by utilizing the normal tendencies and reactions of the immature.

The scientist contemplates the structure of his science as a rigid articulation to be comprehended for its own sake joint by joint, piece by piece, section by section, and finally the structure as a whole. He is displeased if the mind of the pupil runs counter

to the logical process of his science and fails to comprehend it in its entirety. Then he cries, "Force, force without stint or limit."

The principal must perforce contemplate a pupil with a mind stored with a host of indefinite observations and half-formed conclusions touching a multitude of things, mostly phases of his natural and more immediate environment, waiting to have these observations set one by one into their relative positions, further elucidated, and added to. He contemplates a pupil with a mind expanding, working into unknown fields, getting acquainted with the life and habits of the things about him, getting nearer to the mind of man through his works, nearer to God through His laws.

Such, then, is the view-point of the principal with an eye single toward the development of the pupil. The logical organization of the pure sciences is recognized by him as a factor in child development, but is not within his province as a matter of deep concern. He is glad to leave that to the competent hands of the scientific research worker.

The logical order of development of each formal science from its first principles to the ultimate unknown is relatively fixed and unchangeable. It strikes straight through the ordinary interests of life as a dike through the strata that it has cleft. The principal admires and honors it for its individuality and its rugged strength. He does not dispute its facts, or doubt its permanence, or desire its destruction. On the contrary, he plans to examine it, and appropriate as much of it as needful, and in the order that suits his purposes.

He uses it but he refuses to be stopped by it, loaded down or crushed or turned aside by it, or forced to travel down the length of it when the way he travels does not coincide with it.

His way is the way of child development, and there is no one who presumes to say that child development is in any way a counterpart of or contiguous for any considerable length of time to the development of any science in the traditional curriculum.

The sciences are the rounds of the ladder by which the pupil mounts. They are not poles which must be climbed. The sciences are far extending, so as to form a foothold for the race; the breadth of footing that each one may claim depends upon his interests and the amount that he may need in his particular ascent.

Thus the individual and his progress are the principal's con-

cern. The concerns of others are legitimate, but without his field.

From this particular point of view we shall consider the subject of general science.

The pupil progresses by excursions into his environment, and by the subsequent establishment of a recognizable relationship between his new acquaintances and his old familiars. His field of environment is of three dimensions, and his progress is symmetrical only when allowed to extend freely in more than one direction. Thanks to his immaturity and its wonderful laws of growth through constant readjustment, his progress is broken, irregular, and in many directions.

The attempt to serve three-dimension minds with one dimension subjects led to the introduction of the pure sciences into the first two years of high school. The pupil was to be shown the error of his youthfulness; his mind must put on the garb of maturity. By means of the scientific X-ray he was to master the complete skeleton before he could recognize the external features or learn the members' uses. He was forbidden to pass the boundaries from one science to another in his investigation of his problem. The sciences must not fraternize or intermingle in the same lesson, for fear they would lose their racial characteristics. At least, if they did, they must not count toward college entrance.

Such for a long time have been the limitations under which we have worked. But it was affirmed last week at the Illinois High School Conference that the sciences in the first two years of the high school are losing ground, and that the only preserved specimens of these sciences would shortly be found in the college museums, along with the remains of the dodo, dinosaur and other unadaptable creatures.

Our esteemed Chairman himself has presented evidence that left to themselves the sciences now offered in the first two years of the traditional course will at the present rate all come to a timely and ignominious end within a period variously estimated at from five to fifteen years.

While possibly not so serious as this, there is little doubt that this tendency itself is a large contributing factor to the rapid increase of agriculture, domestic science, and manual training. These subjects are not so much crowding out the oldline sciences as they are filling up the vacuum left by the departure of the sciences. Upon the sciences, as upon such studies

as Latin, pressure must be exerted to help them retain their place in the curriculum, and they slip a little farther from their place every time the pressure is relaxed.

The sciences of agriculture, domestic science, and manual training afford a certain measure of relief in the direction of general science, and at the same time satisfy a certain demand for vocational specialization. Yet these sciences are recognized as vocational entirely too restricted to furnish the broadest field for symmetrical growth.

Outside of the nature of the actions and reactions of the pupil in his acquirement of knowledge, the principal will consider from the administrative point of view the large percentage of children who drop out of school at the end of the eighth, ninth, and tenth years. These will enter without further preparation upon as large a measure of the duties and responsibilities of life as they can well or ill assume.

No principal can look with complacency upon such a loss, which amounts to a veritable children's crusade every year, unless he belongs to that group of principals who believe that they are duly constituted and commissioned to act as selective agents to pick out and further the most intelligent and most efficient, and train them up to be leaders, allowing the less fortunate to fall out and become members of the mob that is to be led.

There is perhaps some excuse for such an attitude on the part of the college instructor. A natural law of selection, aided unduly by unnatural high school elimination, has brought to the college a comparative few, who have for the most part some special interest, and who have reached that stage in their development at which they can follow and appreciate to its completion the line of scientific or other theory in which they are interested. Probably at this stage the process of selection and elimination is justifiable.

But the principal of the ordinary high school and the principal of the junior high school receive a large mass of students in whom the special tendencies have not yet begun to assert themselves. Therefore the falling out period has, presumably, not yet been reached. Indeed, it is presumable that the natural falling out period might be expected to occur much later.

But just at this time, despite their omnivorous and highly appreciative but easily surfeited appetites, the students are formed into poison squads and fed upon saltless, sweetless, and

meatless courses with dreary regularity until all but the most robust succumb.

We all have assisted at their obsequies, and have passed resolutions deploring the fact that Divine Providence has seen fit to call them from our midst, etc.

In order to delay the mortality a timely substitution of a rich general science course during the first two years is a sensible and logical step. This course should include the elements of enough of the sciences to make the student at least fairly independent in his problems, and sure of action, and not easily imposed upon. It should be a guide for him to remain in school, and it should be an incentive for him to remain, It should become a tool for him should he leave school, and a basis upon which his maturing process may rest. It should help the student to seek and find, among many paths, that one which will lead toward the land of his soul's interest and his heart's desire.

Another point of great significance to the principal is the use of general science as a means by which the interests of the school can be unified with those of the home. Parents as well as teachers are satisfied with alert and interested children. They prefer vim, snap, and wide-awake intelligence. They do not believe that it injures the habits and control of the pupil to train his attention to the definite, practical problems of everyday life, and to drill him in discovering how these problems are affected by scientific laws. It must be understood, of course, that these problems are to be really studied and the underlying truths really comprehended.

Last Saturday an intelligent patron of a large high school told me that of his five children who are in or beyond high school, the one who took the course in general science was superior in a marked degree to the others in attitude, interest, and improvement. This superiority he ascribes almost entirely to the nature of the subject and its method of presentation. Of course one example is not to be taken as a proof, but it is just exactly in line with the results which we anticipate.

This lad brought general science to his meals three times a day without encouragement, and in fact in spite of discouragement, and commanded the attention of the family to the exclusion of other family interests. He was a discoverer, and after all he was the true scientist. There is no need for a parent to exercise diplomacy to find out what his child is learning at school if the child is studying general science.

To the assertion that specially prepared and equipped teachers must be chosen to handle general science, we would say that certainly that is true. We have them and shall have more of them. Such teachers are demanded in the teaching of any science, and the faults of a poor teacher can be less easily concealed in general science than in any other. It is a study that forces the teacher's hand; it is the maker of good teachers as it is the maker of good students.

These are some of the considerations that have led the principals to seek and adopt general science courses in a thousand high schools within the territory represented by this Association. Many have taken this step in fear and trembling, not because they doubt the efficacy of the new study, but on account of the adverse attitude on the part of college departments and the absolute ban too often imposed by college entrance boards. Many others have been unwillingly forced to neglect the good of the ninety and nine in order to conform to the requirements imposed upon the one who would enter the college or university.

In this body we may at least discuss and resolve without fear of consequences; we are here, fortunately, unhampered by those who would raise obstructions to the admission of general science into the schools. Our declaration of rights has been made. Last week the Illinois High School Conference broke the shackles that had heretofore bound it, and went on record with a positiveness that admitted of no retrogression.

That general science is a method of selecting and presenting the sciences rather than a distinct method, has already been handled theoretically by speakers and will be touched upon in its various phases by others. It is not in any sense revolutionary or destructive. It draws its materials as well from the laboratories of the sciences as from the home, the farm, the shop, and the store. It is a method that accompanies the pupil in his natural progress and his natural development. It has long been demanded by principals and teachers. It is here and it is no longer an experiment. It is a success. In fact, it retrieves the whole science situation. Let us welcome it into our midst as a light bringer to the million.

CAN AND SHOULD GENERAL SCIENCE BE STANDARDIZED?

By C. M. Howe,
Hughes High School, Cincinnati, Ohio.

I do not pretend to be an expert in general science. My excuse for appearing here to speak on such an important subject is that I wish to represent the rank and file of the teaching profession, and that I was privileged through a study carried out last spring to get reactions from a large number of general science teachers on the subject of this paper. However, before presenting to you the results of that investigation, I shall be so bold as to place before you briefly, as supporting considerations, some of the beliefs that motivated my attack on this problem of standardization of general science. I shall give each in the form of a positive assertion, or thesis, with a short defense of its validity.

First of all, general science is losing, and has lost, standing and repute on account of the indefiniteness, superficiality, and vagaries of many texts, courses, and notebooks. Three summers of graduate study in the company of school administrators have shown me the skepticism, if not hostility, of many of them. They would point to the lack of agreement and one-sidedness of most of the earlier texts, and protest the impracticability of teaching without a text for the average teacher. And my own analysis of a number of pet note-books which have come into my hands has made me distrust the fanatical enthusiasm of the proponents of a free-for-all general science, leaving all choice of content to any and every teacher. In very few schools is the general science course considered of serious value by other teachers, often not by the pupils themselves.

Moreover, I believe that amply sufficient time has elapsed since its introduction for free tentative experimentation, and now some definite results may be reasonably expected. After an average experience of five years, and more in many schools, the teachers of general science should surely be able to agree and settle on certain sane and worth-while foundations for a standard course. The latest texts show a marked influence of such crystallization of opinion, and my own study gave remarkably consistent results.

In the third place, there is a demand on the part of other teachers, of administrators, and of the public, for a definite answer to the question, "What is general science?" Other teachers would be glad of some reliable basis of coordination, as in English or history, and a definite idea of previous preparation

for special work in chemistry, physics, or biology. In more than one letter or discussion I have heard principals demand definition to make possible intelligent exchange of credits, and evaluation of existing doubtful courses—(colleges). And I am told that in some cases parents and pupils, after a period of over-expectant enthusiasm, have demanded a return to the certainties of biology or physiography, rather than the intangible wonders of general science.

In the next place, there is a grave danger of injustice and wrong to large groups of pupils, in leaving them at the mercy of uncontrolled and unguided faddists. In no other subject would the crude experimentation and camouflage be tolerated that characterizes some notebooks I have seen. If there are assured values in the subject, the boys and girls are entitled to those values, and no extreme of inductive development or project work should leave the feeling voiced by one boy, "Aw, she didn't give us anything that amounted to much, fussed around a whole week to find out something we all knew, and not a bit of electricity."

Moreover, many general science teachers, with crowded programs and lack of experience, or with a narrow, one-sided preparation, are in need of guidance. It is well enough for our normal school friends and teachers in model schools or universities, who are given time for creative work, to devise marvelously adapted courses, but it is too much to expect of the victim of five distinct subjects or thirty teaching periods per week. True, such an one may follow a text, but which one? And it is an ever-present temptation to teach nearly all botany, physiography, or physics, whichever is most familiar, and omit the rest.

And so, for the sake of the subject, and all concerned, public, administrators, pupils, and teachers, I advocate as the next logical step in the development of general science, a progressive standardization of the subject, based on a preliminary study of dominant aims or purposes, and leading to an agreement on certain minimum essentials and the formation of tentative lists of topics, both fundamental, and optional or selective. On the other hand many will at once see the danger of overstandardizing so as to discourage initiative and local adaptation, and there are two other dangers in such movements, that of domination by the college or normal school, and of the undue influence of a few specialists or enthusiasts. Yet, if we neglect this task, it will be carried out almost unconsciously and perhaps unsatis-

factorily to the great mass of teachers, by book companies, text-book writers, and academic departments of education.

So now I arrive at the foremost tenet of my creed. The sane and sound basis of any such standardization is through a wide cooperation of teachers actually in the work, and determined by the composite experience and judgment of the largest possible groups. Perhaps the best example of such a practical method of definition of secondary subjects is the work of Dr. L. V. Koos of the University of Washington, done for the North Central Association and published as an educational monograph of the University of Chicago. He applied the questionnaire method to secure a composite picture of the current practice in various high school subjects as a basis for definition of units.

A similar method but more intensive and searching is the logical one for a movement toward standardizing general science. And what better agency for its initiation could there be than such an Association as this, with a considerable membership, and able to command the respect and cooperation of large groups of teachers?

So we turn to the question: Is standardization possible, will such a method work? I wish to present as my principal exhibit in evidence, the results of a questionnaire study, carried out with the cooperation of Professor Hall-Quest of the University of Cincinnati, and of *General Science Quarterly*, in the May issue of which it appeared. The editor of the *Quarterly*, from his mailing list, furnished me with a selected list of teachers of general science, from which I made a further selection of 150 names, on the basis of wide geographical distribution and similarity of conditions and problems with those of Cincinnati, as I was anxious to make the study of immediate value at home.

To these teachers I sent out a questionnaire, which is reproduced in my detailed account of the study. Slightly to my own disappointment, but to the surprise of those of wider experience with lengthy questionnaires, I received eighty usable replies, in time for compilation. These I scored and combined by carefully considered methods, which will appear in the examination of the results.

First, let us consider the light shed by this study on dominant aims of general science, which must, of course, underlie and determine the choice of subject matter. I attempted to reduce to a clear and concise form, nine aims which I had found most commonly championed in the articles on general science, prefaces

to texts, and discussions of science values in education. They were phrased in the questionnaire as follows:

Aims.—General science in the first years of high school should give each pupil:

(*a*) A fund of valuable *information* about nature and science.

(*b*) The greatest possible understanding, appreciation, and control of his everyday *environment*.

(*c*) *Preparation* and foundation for the later study of special sciences.

(*d*) Appreciation of the *applications* of science in modern industrial and social life.

(*e*) Training in the use of the *scientific method* in solving vital problems.

(*f*) A *vocational* survey of the sciences to guide and inspire plans for life work.

(*g*) *Interest* and motivation to vitalize his work and prevent his elimination.

(*h*) *Appreciation* of the unity and beauty of science, and of the work of its master minds.

(*i*) Training in cold, scientific thinking, carried on with strict self-elimination. (Coulter.)

The teachers who replied were asked to rank these aims as nearly as possible in order of their judgment of their importance. The results of the tabulation and scoring of these aims is seen in the following table:

AIM OF GENERAL SCIENCE—AS RANKED BY EIGHTY TEACHERS.[1]

The Aim of General Science is to give each child	Rank—As given in 80 Questionnaires 1	2	3	4	5	6	7	8	9	Total Score
1. Understanding, appreciation, and control of his everyday *environment*......(*b*)	53	10	7	2	4	3	....	....	1	149
2. Appreciation of the *applications* of science in industrial and social life......(*d*)	5	23	15	17	11	2	5	2	....	282
3. A fund of valuable *information* about nature and sciences......(*a*)	12	13	13	17	10	7	4	3	1	293
4. Training in use of the *scientific method* in solving problems......(*e*)	8	11	12	14	7	7	11	9	1	357
5. *Preparation* and foundation for later study of special sciences......(*c*)	6	6	10	11	14	8	12	11	2	400
6. *Interest* and motivation in school work to prevent his elimination......(*g*)	1	10	12	9	10	15	13	8	2	406
7. A *vocational* survey of sciences to guide and inspire life work......(*f*)	1	7	9	8	17	16	13	6	3	421
8. *Appreciation* of the unity and beauty of science and of its master minds......(*h*)	1	2	5	5	10	16	11	27	3	506
9. Training in cold, scientific thinking involving self-elimination......(*i*)	1	3	5	4	3	2	4	6	52	609

[1]Some teachers insisted on ranking the aims by groups, rather than in order from first to ninth. For example, one would mark several aims, such as (*b*), (*d*), and (*a*), all *first*, (1), another group (2), and the rest all (3), etc. Such irregular scoring causes some of the ranks to total vertically slightly more than 80, and others less than 80, but does not at all affect the validity of the comparison.

Hence from the showing of the three leading aims, the dominant purposes of general science are to give each pupil the greatest possible understanding, appreciation, and control of his everyday *environment*, to acquaint him with some of the most important industrial and social *applications* of science, and to furnish as wide a fund of *information* about nature and science as time permits. The ranking of these aims may seem more

valid when we note that those finally ranked 1, 2, 4, 5, 6, 8, and 9, have also modal frequencies in those respective ranks.

The other contribution of this paper to the technique of standardization was an attempt to formulate lists of fundamental and of optional topics. The questionnaire included a list, which I need not repeat here, compiled from a study of texts, syllabi, and courses, and from analyses of texts like that of Prof. H. A. Webb. The teachers were asked to mark these topics as Fundamental, (F) or Supplementary, (S), according to their belief that they were essential to any course in the subject, or only of possible value as optional material. On scoring these topics I secured the following interesting lists as tentative standards:

List 1.—Fundamental Topics, or Minimum Essentials, of General Science.

		Scores. F.	S.
1.	Water—Physical properties and mechancis of liquids	73	4
2.	Air—Chemical composition and combustion	71	6
3.	Air—Physical properties and mechanics of gases	69	7
4.	Ventilation	63	15
5.	Household heat and light	62	15
6.	Water supply and purification	60	15
7.	Weather and climate	59	15
8.	Bacteria, yeasts, and molds	58	10
9.	Foods—Diet and digestion	57	9
10.	Combustion and fuels	56	16
11.	Hygiene and sanitation	55	9
12.	Water—Chemical properties	55	17
13.	Plant life—Elementary botany	50	9
14.	Everyday chemistry (salt, ammonia, carbon, etc.)	49	19
15.	Simple machines	48	13
16.	Force, power, and energy	47	11
17.	Animal life—Elementary zoology	46	12
18.	Systems of measurement	43	21
19.	Acids, bases, and salts	43	21
20.	Elements, compounds, and mixtures	42	20
21.	Density, specific gravity, and buoyancy	42	18
22.	Electricity and magnetism	41	25

List 2.—Supplementary Topics—Optional Material.

		Scores. F.	S.	Total.
1.	Household chemistry (soda, stains, etc.)	35	30	65
2.	Coal, gas, and petroleum	39	25	64
3.	Molecular theory	40	22	62
4.	Light and its relation to life	40	20	60
5.	Astronomy and star study	23	37	60
6.	Soils and rocks	37	22	59
7.	Steam and gas engines	20	39	59
8.	Plumbing and household appliances	32	26	58
9.	Sound and its relation to life	26	30	56
10.	Cooking and baking	13	33	56
11.	Elements of physiology	40	15	55
12.	Iron, steel, and metals	17	36	53
13.	Trees and flowers	23	29	52
14.	Theory and laws of heat	29	22	51
15.	Drugs, narcotics, and alcohol	20	31	51

A close analysis of the first list will show a remarkable consistency of this judgment of a majority of our eighty teachers with the three basic aims: Environment, application, information. No one is more keenly aware than the speaker of the criticism which may be applied to this study in detail; it is tentative, not in any sense perfect, or complete. The greatest difficulty is that of fair and satisfactory phraseology, to state the aim briefly yet inclusively, so as to present clearly the values most commonly claimed. And even more difficult is the analysis of subject matter to form lists of practicable size, so worded as to get the opinions of the advocates of a project method of presentation, and also of the users of a text and more formal methods.

I felt more and more keenly, with each answer, and the letters of varying import, the need of collective wisdom and the preparation of a similar questionnaire by a well-chosen committee. Such cooperative revision would no doubt vastly increase the definiteness of the result and improve the method.

But even in its present form certain uses occur to me which illustrate the desirability of a thorough following up of this work. The study is of value:

1. As a criterion of judgment, and selection, of subject matter for general science teachers.
2. For administrators as a means of evaluating the scope of such work in their own schools, and as a basis for the exchange of credits.
3. As a means of comparing and judging textbooks. It was my recent privilege to present such an analysis of the leading texts before our Cincinnati teachers for guidance toward the the choice of a text for a five-year term.
4. As a guide to the extensive and practical training of teachers for this subject. A normal course in general science along recognized lines would be of supreme value in every summer school.
5. As a beginning and entering wedge to bring about a concerted movement in this direction to establish the values and standing of general science.

In direct sequence to the last statement, I shall now have the temerity to present a possible program of standardization to be carried out by this section of the Central Association.

A. The appointment of a committee to study the statement of dominant aims, the analysis and classification of subject matter, and the common elements of home and social environment.
B. An extension and improvement of the questionnaire method to submit the findings of this committee to a large group of teachers and obtain their reaction and composite judgment.
C. A compilation and publication of these results to give a more authoritative answer to the question, "What is general science?" including dominant aims, lists of minimum essentials and of valuable supplementary material, and perhaps the drafting of a logical course as a tentative standard.

D. Sufficient scope will remain for individual initiative and exploration along the following lines: Details of method and concrete material, studies of local environment to get actual life contacts, development of special types of supplementary material suited to local demands, and a sane combination of intensive project study with extensive acquaintance with a complex environment.

My attention has been drawn to the importance of the work of the committee, outlined in A, the analysis of subject matter in relation to environment, from a recent experience in outlining a course in trade science under the Smith-Hughes Law. I finally based it on a number of personal visits to Cincinnati factories and the thorough analysis of the trades involved in a number of industrial and vocational surveys.

My own attempt illustrates the questionnaire method for Division B. And finally in connection with Division C, I wish to give an outline course of essentials based on the list formerly read.

OUTLINE COURSE BASED ON QUESTIONNAIRE LIST OF MINIMUM ESSENTIALS.

I. Commonest Elements of Environment.
- (a) The air—Physical properties and mechanics of gases, chemical composition, and combustion.
- (b) Water—Physical properties and mechanics of liquids, chemical properties, water supply, and purification.
- (c) Weather and climate.
- (d) Household heat and light, fuels, ventilation, foods, diet, and digestion.

II. Special Physical Environment and Applications.
- (a) Systems of measurement, density, specific gravity, and buoyancy.
- (b) Force, power, and energy in our world; simple machines.
- (c) Electricity and magnetism, a new century.

III. The Chemical World Around Us.
- (a) Elements, compounds, and mixtures.
- (b) Acids, bases, and salts.
- (c) Everyday chemistry—Salt, ammonia, carbon, etc.

IV. The World of Life.
- (a) Animal life—Elementary zoology of environment.
- (b) Plant life—Elementary botany of environment.
- (c) Bacteria, yeasts, and molds.
- (d) Hygiene and sanitation.

I realize fully the criticism that may be brought, that this outline is an assemblage of material and topics from special sciences. But is it not entirely recast and organized in the light of our three dominant aims? And, of course, every topic should be presented in a simple, vital way characteristic of general science.

To speak frankly, there is a gulf between the dizzy heights of pedagogical theory and the humbler plateau of actual practical teaching in our high schools, especially with the overcrowding and varied environments of our cities. An absolute breaking

away from all the tested and often invaluable subject matter and methods of the special sciences is a brave and lofty ideal, but is it safe or successful with the average teacher?

Elaborate notebooks are beautiful to look upon, but they must remain a means, not an end, lest they should monopolize for showy and superficial compilation of a narrow or mediocre text, time more valuable for thought, discussion, and more extensive contacts.

The project method may very often be one of absorbing interest and value, but may not its exclusive or extreme use tend to give a one-sided intensive result, and cheat the large number who will have no special science?

The friends of general science find in it the promise of a most valuable broad introduction to scientific thought and fact, of superior merit both for pupils who may continue in special science courses, and for those to whom it is the only chance to survey this realm. Any discredit of this work is due to faddism, extremes of theory and idealism, and to its intangibility. I have tried to suggest a remedial reform based on the broad experience, the practical sense, and the composite judgment of the rank and file of teachers of general science.

For this reason alone have I considered my study of any interest to you, and to this end I again petition this body to consider some such program of extension of the work of cooperative standardization, as that which I have outlined.

MINUTES OF THE GENERAL SCIENCE SECTION.

The first meeting of the General Science Section of the Central Association of Science and Mathematics Teachers was held Friday afternoon, November 29. Mr. Fred D. Barber, Illinois State Normal University, Normal, Ill., presided. In the absence of the Secretary of the section, the Chairman appointed Miss Sylvia Smith of Evanston, Ill., as Acting Secretary.

Dr. J. C. Hessler, Decatur, Ill., was appointed as Chairman of the Nominating Committee.

A committee with Mr. Fred D. Barber as Chairman was authorized to present the matter of a permanent organization of the General Science Section to the Central Association of Science and Mathematics Teachers at the Saturday morning business meeting.

The first paper was presented to the section by Dr. Daniel R. Hodgdon, Newark Technical High School, Newark, N. J., on "The Psychological Basis for General Science." Dr. Hodgdon thinks that general science is a movement in the direction of recognizing the child, and of presenting to him scientific materials which are vital, interesting, and useful to him. Although the psychology of the child is better understood than at any time in the history of education, many teachers still have only their subjects at heart, and not the interests and training of the child. The

materials selected for the presentation of general science should be ones which will vitalize, socialize, and visualize the everyday experiences of our boys' and girls' lives. Dr. Hodgdon gave many examples to show that frequently pupils cannot associate the abstract facts which they have learned in science with the things which happen in their everyday experiences. He further pointed out the fact that with a little guidance and encouragement from the teacher, pupils soon realize that they can understand some of the things which are going on about them. They can be trained to observe more accurately and to react to their environments. In the selection of materials for the teaching of general science Dr. Hodgdon started with the home as the center of all activities. But he found that this would not cover the field of the pupil's interests, so he added outside subject matter, especially such as would function in the lives of pupils in going to and from school. He considers the chief reason for the study of general science is to give the consumer knowledge. We must know about our food, clothing, ventilation, water supply, heating systems, etc. All such material is included in the practical science of everyday life and should be included in our first-year science courses.

Dr. J. C. Hessler, James Milliken University, Decatur, Ill., in his discussion of Dr. Hodgdon's paper, said that science must become, in an enormously increasing degree, the object of study of American students. The question which then confronts us is whether or not general science will make students want to know more about their world, and as a result pursue courses in biology, physics, chemistry, and the other special sciences. Dr. Hessler feels that the time has come for us to cease recommending general science on the basis that it does not necessarily lead to the other sciences. He thinks it is absolutely worthless unless it does make the student want to take more science. "It is to fundamental science," he says, "that we must look, not merely for experts in medicine, surgery, engineering, and military affairs, but also for the existence of a body of knowledge that will make moral, social, and sanitary progress possible in the immediate future. There will be need of scientific feeding, scientific housekeeping, scientific physical development, scientific social organization."

Dr. Hessler agreed with Dr. Hodgdon that general science has come to stay, and its methods will be felt far outside of its own boundaries in the humanizing of the special sciences. An introductory course in science should train the pupil in scientific thinking and living, and at the outset of his secondary education he should receive "an abiding impression of the orderliness and beauty of nature and of nature's laws."

Following a general discussion, Principal R. G. Beals, Township High School, Taylorville, Ill., presented his paper on "General Science from the Viewpoint of a Principal." Mr. Beals pointed out the fact that in the past principals have had little part in the formulating of courses in science. This task has been left to the scientist, who unfortunately in the past has had too much regard for science itself, which he has striven to preserve in its strictly logical form. The principal, on the other hand, has always kept the development of the pupil in mind. These two viewpoints, which have not always coincided, Mr. Beals thinks are being brought to an agreement through general science. Some of the improvements which he thinks should be brought about through the introduction of general science are: it should serve as an incentive for pupils to remain in school; through it the interests of the home can be unified with those of the school; science teaching should be improved because the faults of a poor teacher can less easily be concealed in general science.

In the general discussion which followed this paper, Dr. Hessler asked,

"What special science teacher makes the best general science teacher?" Mr. Beals replied: "A teacher who is a special science teacher will not be the best. I prefer one who has had a broad training in all lines of science." Mr. Howe thought that the criterion was not so much which special science the teacher had taught, but his general attitude toward science teaching.

Because of the illness of Mr. George Mounce, Township High School, LaSalle, Ill., his paper on "Some Tangible Results of General Science Teaching" was not given.

It was the unanimous opinion of the forty persons present that the meeting had been a most interesting and helpful one. The meeting was adjourned until 10 a. m. the next day, November 30.

On Saturday morning the meeting was called to order by the Chairman. Mr. Clarence W. Schrock, Pontiac, Ill., was appointed to act as Secretary.

The Nominating Committee submitted the following report:

For Chairman—Fred D. Barber, Illinois State Normal University, Normal, Ill.

For Vice-Chairman—Ernest B. Collette, Lake View High School, Chicago.

For Secretary—Ada L. Weckel, Oak Park and River Forest Township High School, Oak Park, Ill.

This report was accepted.

The appointment of a Committee on the Reorganization of High School Studies was next considered. The section voted that the officers of the section should constitute such a committee.

The program opened with an excellent paper on "Can and Should General Science Be Standardized?" by Mr. Clayton M. Howe, Hughes High School, Cincinnati, Ohio. Mr. Howe assumes that enough time has elapsed since the introduction of general science for free tentative experimentation, and he thinks that now some definite results may be reasonably expected. For the sake of the subject, and all concerned, the public, administrators, pupils, and teachers, Mr. Howe advocates as the next logical step in the development of general science, a progressive standardization of the subject, based on a preliminary study of the dominant aims or purposes, and leading to an agreement on certain minimum essentials and the formation of tentative lists of topics, both fundamental and optional.

With these two ends in view the writer sent out a questionnaire and received eighty usable replies. The results of this survey showed the three leading aims in general science are to give each pupil the greatest possible understanding, appreciation, and control of his everyday *environment;* to acquaint him with some of the most important industrial and social *applications* of science; and to furnish as wide a fund of *information* about nature and science as time permits.

From the replies to the questionnaires Mr. Howe, in an attempt to standardize the topics given in general science, also made out a list of fundamental and optional topics presented.

Mr. Howe recognizes the fact that the methods which he used in this study might be open to criticism, but he impressed the members of the section with the value and the necessity of the preparation of a similar questionnaire by a well-chosen committee. Such cooperative revision would be more thorough, and would vastly increase the definiteness of the result, and improve the method.

A discussion of Mr. Howe's paper by Mr. C. Frank Phipps, State Normal School, DeKalb, Ill., followed. The necessity of the needs and the

possibilities of the standardization of the courses in general science were further urged. Such standardization would make for better organized courses and would thus remove one of the most frequently offered criticisms to general science.

The last paper read before the section was on "General Science in Illinois," by Superintendent C. F. Miller of Normal, Ill. The materials of Mr. Miller's paper were based on the results of a survey which he made in Illinois to determine the present status of general science in that state. Through his questionnaire he found the objections to the introduction of general science to be based primarily on a lack of unity in aim, a lack of standardization and organization in content, a lack of properly prepared teachers, and the fact that the course is not accredited at the universities.

In conclusion, Mr. Miller said, "I believe enough pioneering has been done in Illinois to offer sufficient data that will warrant a unified effort to suggest a practicable working basis of organization around definite aims that will before any great length of time lead to a solution of our ninth grade science problem."

After a brief discussion, the meeting was adjourned.

ADA L. WECKEL.

SIGNPOSTING THE DESERT.

The United States Geological Survey, Department of the Interior, has surveyed and signposted a great area of the most dangerous desert region of the United States. The Thirty-ninth Annual Report of the topographic division of the Survey, just made public, describes the method employed of making the desert safe to the unwary traveler.

The region surveyed occupies about 60,000 square miles in southern California and southwestern Arizona. In California it includes the southern part of Death Valley and the region between this valley and the Mexican border; in Arizona it includes the region west of Tucson and Phoenix and south of Wickenburg and Parker. This region was selected because it is the driest, hottest, and least explored part of the desert region, and also because of the strategic importance of obtaining information on the water supplies along the 350 miles of national frontier that it includes. The field work was done by four parties, each of which consisted of one geologist and one nontechnical assistant outfitted with an automobile and light camping equipment. Practically all watering places in the region were examined, about 160 samples of water were collected and shipped to the water-resources laboratory at Washington, D. C., for analysis, and a general exploration was made of the geography, geology, and ground-water conditions of the region. The maps prepared and the data obtained were made available to the Army engineers for incorporation in the progressive military map of the United States. Guides with maps are being prepared for publication.

Signs directing travelers to water were erected at 167 localities in California and 138 in Arizona. The signposts are galvanized iron, 1.9 inches in outside diameter and 12 feet long. Each post is anchored in the ground with two redwood blocks. The signs are 18-gage steel, galvanized, are white, with dark-blue letters, and are substantially bolted to the posts. They are of two sizes, 18 by 20 inches and 9 by 20 inches. Most of the larger signs, of which 470 were erected, give the names, distances, and directions to four watering places; most of the smaller signs, 165 of which were erected, give the names, distances, and directions to two watering places. The work done last year is a part of a comprehensive plan for mapping and marking the watering places in the entire arid region lying east of the Sierra Nevada and Cascade Mountains and west of a line running approximately from eastern Oregon through Salt Lake City and Santa Fe to the mouth of Pecos River.

FINAL REPORT OF SUBCOMMITTEE ON CONTENT OF COURSE IN FIRST-YEAR MATHEMATICS.

A—In General.

I. The work should have a unifying thread throughout. The unifying thread should be the algebraic equation.

II. The work should include:

(a) Arithmetic with special emphasis on fractions, decimals, and approximate computation. This review of arithmetic should continue throughout the year and not be confined to a few days at the beginning of the year.

(b) Observational geometry introduced for the purpose of:

1. Furnishing interesting applications of the algebra.
2. Training pupils to "see figures."

(c) Elementary algebra.

B.—Method of Treatment.

I. It should not be considered necessary to "finish" any topic in the first year.

This idea that certain topics can be so thoroughly taught in the first year that it should not be necessary to review them in the second course, is responsible for the introduction of many exercises in the first year that are too complicated for beginners. For an extreme illustration of what is meant, see examination questions in Algebra 1A of College Entrance Examination Board. Sometimes exercises in what might be considered more advanced topics are really easier and more interesting than complicated exercises in multiplication or division.

II. In algebraic work stress should be placed on simple exercises, and all that is at all complicated should be omitted.

It should be noted that drill on the fundamental processes should be continued until the process becomes automatic. This drill should, however, be by means of simple, easy exercises. Too often the point of the algebra is missed in the mass of details and the complicated exercises presented. In a desire to "finish" certain topics in a given time, the easier exercises from which algebraic principles may be taught are slighted, and complicated exercises are given. The result is lack of thoughtful insight which might help to make the impression permanent.

III. The meaning of algebraic expressions should be made clear from the beginning.

As a rule two or three lessons are given to this topic and it is then dropped. Not only should more time be given to it at the beginning, but it should be introduced as often as possible when

the pupil is studying other topics. Neglect of this point has a great deal to do with the pupils' difficulties. The fact that many texts fail to devote much space to simple exercises that are planned to show the meaning of algebraic expressions, causes many teachers to overlook its importance. The desired result may be obtained by frequent evaluations of algebraic expressions, by spending more time on oral work, such as work with the equation in its simplest forms and with the fundamental operations with monomials, and by translations of algebraic expressions into English and of English into algebraic expressions. Evaluations of algebraic expressions may profitably include work with simple, well-known formulas, such as $s=\pi R^2$, $s=1/2bh$, etc. The geometry work suggested in E. I,*c* furnishes excellent material for such formula work.

IV. Care should be taken in the terminology used.

Many terms and phrases used mean little or nothing to the children, and often serve to conceal ignorance. Words or phrases that require translation, such as cancel, transpose, etc., should be avoided.

V. General principles should be emphasized, for example:

(a) The fact that the product divided by one factor equals the other factor.

(b) The fundamental law of fractions, that numerator and denomination may be multiplied and divided by the same number without changing the value.

(c) To multiply a product by any number, multiply one factor of the product by the number.

(d) To multiply a sum or difference by a number, multiply every term of the sum or difference by the number.

(e) In work that involves identities, no values must be changed.

VI. Equations with applications to verbal problems and all topics requiring original thinking should be emphasized.

Work with the equation should be the prominent thing. In emphasizing the equation two points are involved:

(a) Solution of numerous verbal problems.

(b) The introduction of equations with other topics.

Many topics such as special forms of multiplication and factoring are not always thought of in connection with the equation. At the time when topics are taught the principles involved in them should be applied to the equation.

At the end of the first year a pupil should of his own accord

attack problems by means of equations, and express quantitive relations in a symbolic form that appeals to the eye and simplifies the solution of the questions involved.

It should be noted that what is concrete to one person is not always concrete to another. This is particularly true of many problems taken from special industries. Problems taken from third-and fourth-year course in high school physics have nothing in them that is concrete to ninth graders. It is safe to say that many pupils would fail to see anything concrete in such a question as: Sketch a rectangle where area is $14\ a^2b^2c^2-21a^2b^2c^2+35a^2b^2c^3$. It should be noted also that what is interesting to an adult is not always interesting to children.

VII. Checking should be emphasized.

Checking serves several purposes.

(*a*) It shows the necessity and value of checking.

(*b*) It increases the opportunity for evaluation and for drill in arithmetic manipulation.

(*c*) It affords opportunity for explanation of the meaning of the algebra involved.

Checking should be avoided if the check is worse than the problem itself.

VIII. Graph work should be distributed throughout the course and made a help to other parts of the work, not merely an end in itself.

Where possible graphs should be used as a method of solving verbal problems. It should precede, not follow, simultaneous equations. Linear graphs, that is forward and back on a straight line, should be used from the beginning of negative numbers.

IX. Geometry material should be used freely.

This material furnishes applications of the algebra learned which may be made interesting and valuable. The truth of the facts used should be made evident by informal treatment rather than rigidly demonstrated. In order to train pupils to "see figures," the figures should be carefully drawn. Often paper folding may be substituted for the use of the compass.

C.—The Minimum Algebra Requirement—Order of Topics is Not Considered.

I. Evaluations of algebraic expressions and the use of formulas.

It is not intended to imply that the evaluations of all possible types of algebraic expressions should be given at the outset. Algebraic addition and subtraction can be effectually taught from such simple expressions as $3b-2b-4b+7b$. This can be

accompanied by the evaluation of the expressions used. The evaluation of such forms as, a^4, $3a^5$, etc., may be well given as an introduction to the multiplication of such forms $(3a^2)$ $(5a^3)$. This tends to keep the real meaning of the forms used constantly before the pupil.

II. Meaning of and operation with positive and negative members.

III. The fundamental operations.

The fundamental operations with simple expressions should be emphasized.

Complicated expressions should be omitted.

Omit all work with fractional, negative, and literal exponents.

IV. Special cases of multiplication and factoring.

In general this is overdone. The work with the simple cases should be stressed. The work may be confined to the following types as applied to binomials only:

In special products:
(*a*) Square of the sum.
(*b*) Square of the difference.
(*c*) Product of sum and difference.
(*e*) Product of two binomials.

In factoring:
(*e*) Polynomials whose terms have a common monomial factor.
(*f*) Binomials that are the difference of two squares.
(*g*) Trinomial squares.
(*h*) The quadratic trinomial factorable by trial.

V. Fractions.

Simple work in fractions should be stressed and may be extended to include review of arithmetical fractions. The fact that second-year pupils hesitate about adding $a/b+1$, may indicate that not enough simple and too much complicated fraction work was given in the first year. Easy fractional equations can be given at the beginning if proper use is made of the pupil's knowledge of arithmetical fractions. Complex fractions should be included, but all work that requires other types of factoring than that listed above and all complicated forms may be omitted.

VI. Ratio and proportion.

This work should be restricted to concrete problems involving proportion. The work should be regarded as a continuation of the work done in fractions. It should introduce as little new matter as possible, and should include many applications.

VII. Square roots of numbers.

VIII. Reductions and addition of surds of the types $\sqrt{a^2b}$ and $\sqrt{a/b}$.

IX. Equations.

Easy equation work should be emphasized. All work in literal equations of the technical algebraic type may profitably be reduced in amount. Formula work is important.

All work in linear simultaneous equations may be confined to equations in two unknowns. The work with fractional literal equations may be reduced in amount and made easy.

Quadratic equations with real roots may be included. They are really not very difficult to solve, even by completing the square, and have more meaning to the pupils and are more interesting than much work in complicated fractions or in radicals and exponents. Irrational roots should be expressed in decimals correct to two decimal places. This gives meaning to the solution and adds to the arithmetic control possible.

D.—The Following Topics Should Be Omitted as Having No Place in First-Year Work.

I. Simultaneous equations of more than three unknowns.

II. The remainder and factor theorem.

III. Properties of proportion, alternation, inversion, composition, and division.

IV. Cube root.

V. Theory of exponents. All operations with exponents not positive and integral.

VI. Extended study of radicals.

VII. Solution of quadratics by the formula.

VIII. Imaginary roots of quadratics.

IX. Operations with imaginaries.

X. Simultaneous quadratics, other than one linear and one quadratic.

XI. Radical equations.

XII. All higher equations, except when solved by simple factoring.

E.—Available Geometry Material.

I. Facts to be used more freely:

(*a*) Facts concerning angles in general:

1. Measurement of angles in degrees.
2. Measurement of central angles.
3. Use of protractor.
4. Supplementary, complementary, and vertical angles.

(b) Facts concerning angles in triangles:

1. The sum of the angles of a triangle.
2. The exterior angle of a triangle.
3. The base angles of an isosceles triangle.
4. The sum of the acute angles of a right triangle.
5. The $60° - 30°$ triangle.

(c) Areas and volumes:

1. Areas of rectangles, parallelograms, triangles, and trapezoids.
2. Volumes of cubes and rectangular solids.
3. Comparisons of areas of parallelograms and of triangles with equal altitudes or with equal bases.

(d) The Pythagorean Theorem.

II. Facts to be used more sparingly:

(a) Parallel lines:

1. Tests for parallels.
2. Equal and supplementary angles formed when two parallels are cut by a transversal.

(b) Proportional segments made by:

1. A line parallel to the base of a triangle.
2. Corresponding sides of mutually equiangular triangles.

CONCLUSION.

In brief, the report advises the reduction of the course, so as to eliminate the facts that are not necessary to a working knowledge of algebra and an arrangement of the work and a choice of topics, exercises, and problems that will throw emphasis upon important principles and will provide work that is not beyond the comprehension of the child. The committee wishes to state that the proposals of this report are not new and wishes to call attention to the algebra report printed in the *Proceedings* of this Association for 1908.

The committee believes that pupils who have had a course as outlined above and had it with a good teacher, will be prepared for the subsequent elective work in high school mathematics. Many teachers find that often pupils who undertake the second course in high school algebra with the courses as planned at present have not the necessary foundation that should have been obtained in the first year. That foundation could be securely laid by making the work more simple while the topics omitted would serve as new material for third semester work.

MABEL SYKES, *Chairman*.

CHARLES AMMERMAN. LEE LEAHY.
CHARLES M. AUSTIN. EDITH LONG.

MINUTES OF MATHEMATICS SECTION.

The Mathematics Section held two meetings on November 29 and 30, 1918.

Friday Afternoon Meeting.

In the absence of the Chairman, Mr. J. A. Foberg of Chicago, Mr. Byron Cosby of Kirksville, Mo., Vice-Chairman, presided.

Prof. L. E. Dickson of the University of Chicago read a paper on "Mathematics in the War."

In his address on "Mathematics in the War," Prof. L. E. Dickson of the University of Chicago spoke of the very accurate methods now employed by the heavy artillery, based on the refinements of surveying and employing trigonometric computations checked by rapid graphical solutions made on a plotting board. The construction of the necessary new range tables has involved the use of quite advanced mathematical theory. Dead reckoning in navigation was considered more fully, beginning with a detailed account of the essential features of middle latitude sailing and Mercator's sailing. For these topics, as well as in the elements of plane surveying, no mathematics beyond plane trigonometry is necessary. It was contended that the elements of surveying and dead reckoning should be introduced into the first course in trigonometry, partly in view of their practical value, partly for the continuity of thought and purpose possible in the problems from these sources, partly for the sake of concreteness, and finally to introduce methods more akin to those in practical life. At least a clear outline of the more advanced subject of celestial navigation might well be given in a serious college course in astronomy. An account was given of instruction in navigation in England and America, especially during the war.

Principal W. B. Owen addressed the section on the "Education of Today." Mr. Owen spoke of the development of public secondary education as related to the development of university education on the one hand, and of elementary education on the other. He said that the problem today is to make a curriculum for pupils who would not carry their education beyond the secondary schools that would, at the same time, care for pupils who would go further. He spoke of the demand for courses that would meet specific needs, and spoke of education as control of developing experience. This gives a new point of view, and a new interpretation of method; a method built upon psychology and a logic of purpose. The control of experience consists in the setting up of some definite purpose and the achieving of that purpose. Experimental science and industry furnish examples of purposeful thinking. Development of children is through problem solving. The curriculum should be organized of distinct units, and each unit a problem that is a real problem outside of school.

Prof. W. W. Hart of the University of Wisconsin read a paper on the "High School of Tomorrow." Mr. Hart protested against an antagonistic attitude in many quarters against mathematics, an attitude based on misrepresentation, misinformation, exaggeration, and discrimination, and gave quotations to illustrate his point. He said that one objection to mathematics as a required secondary study was that training obtained from mathematical logic is not transferable. In reply to this he read a quotation from a monograph by John Edgar Coover of the Department of Psychology of Leland Stanford University on "Formal Discipline from the Standpoint of Experimental Psychology." Mr. Hart discussed the proposals made by some of the critics of high school mathematics; these proposals involve a discussion of what pupils should study mathematics, and the nature of the courses to be given.

A spirited discussion followed, in which the following participated: Mr. W. B. Borgers of McKinley High School, Chicago; Mr. J. R. Clark of Chicago Normal School; Mr. Owen; Mr. M. Holt of Senn High School, Chicago; Miss Ethel Jaynes of Lane High School, Chicago; Miss Mabel Sykes of Bowen High School, Chicago; Mr. C. E. Comstock of Peoria, Ill.; Mr. Hart, Mrs. Mary Devereux of Austin High School, Chicago. The discussion developed some further protests against criticism based on insufficient data, against inefficient teaching, and against that kind of vocational guidance that would attempt to decide the life work of all pupils before adolescence. Mr. Owen, Miss Jaynes, and Mr. Comstock spoke of mathematics in vocational courses.

The Chairman appointed as Nominating Committee, Mr. G. H. Harper, Mr. H. E. Cobb, and Mr. J. R. Clark.

SATURDAY MORNING MEETING.

The Chairman, Mr. J. A. Foberg, of Crane Technical High School, Chicago, presided. The following business was transacted: The Nominating Committee presented the following:

For Chairman—Mr. Byron Cosby of Kirksville, Mo.

For Vice-Chairman—Mr. M. J. Newell of Evanston, Ill.

For Secretary—Miss E. G. Parker of Oak Park, Ill.

The report of the committee was accepted and the above officers elected.

Moved, seconded, and carried that the Committee on Mathematics Requirements be requested to act for the section on questions pertaining to the revision of mathematics courses in the high school of tomorrow, and that the Chairman of the Committee on Mathematics Requirements be our representative on the General Committee of this Association.

Moved, seconded, and carried that the present Committee on Mathematics Requirements be continued.

Moved, seconded, and carried that a voluntary tax of twenty-five cents or more be levied to be used for the expenses of the Committee on Mathematics Requirements.

The financial statement was read. Moved, seconded, and carried that the report be placed on file.

FINANCIAL STATEMENT.

Receipts.

Balance on hand	\$28.13
Received from Central Association Teachers	15.00
Total receipts	\$43.13

Disbursements.

To Edna Allen for Correlation Committee report	\$12.00
To Prof. K. G. Smith, Vocational Committee report	5.15
To Prof. J. W. A. Young, expenses as Chairman	1.25
To Edith Irene Atkin, Publicity Committee report	4.00
To Mabel Sykes, Algebra Committee report	1.80
To W. W. Hart, Algebra Committee report	2.75
To J. A. Foberg, committee report	14.10
Total disbursements	\$41.05
Balance on hand	\$ 2.08

Respectfully submitted,

EDITH IRENE ATKIN, *Secretary.*

The Chairman reported that in addition to the balance reported by the Secretary, there was on hand \$12 collected last year by Mr. C. E. Comstock for the expenses of the Committee on Mathematics Requirements.

The Chairman reported that as the S. A. T. C. men were about to demobilize, no speaker on the movement had been provided.

Miss Mabel Sykes, Chairman of the Sub-committee on Content of Course in First-year Mathematics, presented the final report of the subcommittee. Miss Sykes gave some account of the history of the report. Because of the influenza epidemic it had not been possible to hear from all members of the committee before it was necessary to duplicate the report. Some minor changes were therefore made in the copies circulated. Certain disputed points were presented, which were later acted on by the section, and either included or excluded from the report.

Mr. H. E. Cobb stated that the report would be published in SCHOOL SCIENCE AND MATHEMATICS.

Miss Sykes contrasted the requirements of the College Entrance Examination Board in Mathematics, A-1 (presumably first-year algebra), with the recommendations of the report, and stated that here seemed to be one serious obstacle to the widespread influence of the report.

The report of the Sub-committee on Content of Course in First-year Mathematics was unanimously adopted.

Moved, seconded, and carried that this Association request our representative on the National Committee on Mathematics Requirements to send the algebra report as soon as possible to the Chairman of said committee, with the request that pressure be brought to bear on the College Entrance Examination Board for a redefinition on the Mathematics Requirements, especially of those for mathematics, A-1.

The section adjourned.

MABEL SYKES,
Acting Secretary.

MINUTES OF PHYSICS SECTION.

The meeting was called to order by Chairman W. R. Ahrens, Englewood High School, Chicago, at 1:45. Present when meeting was called, twenty-nine. Number present at one time or another during the meeting, forty-one.

The Chairman explained that the entire program as printed had been abolished, owing to inability of speakers to be present. A program had been hastily prepared within the preceding two days.

The Chairman reviewed the work of the section for the past year, reading part of the report of the financial condition of the Association, showing substantial increase in membership.

Mr. W. E. Tower, Englewood High School, Chicago, brought up for discussion the matter of material to be preferred for laboratory table tops, for physics. After some discussion, Mr. Turton, Bowen High School, Chicago, made the following motion:

"RESOLVED, That it is the opinion of the Physics Section of the Central Association of Science and Mathematics Teachers that laminated wood tops are to be preferred to stone or any other material for physics laboratory tables."

This motion was carried by a standing vote of twenty-four to one. The Secretary of the section was then directed by the section to communicate this fact by letter to the architect of the Chicago Board of Education, explaining the reasons, as brought out in discussion, why wood was preferred. Mr. Stoneking of Wendell Phillips High School, Chicago, explained that an acid-proof compound for treating the table tops was available, either from the scientific supply houses, or could be made.

Mr. A. W. Augur, Tilden High School, Chicago, read a paper contrasting very forcibly the aims of the German school system with the American. A very interesting feature was his reading of some actual verbatim lessons, stenographic reports, of the recitations in history, geography, etc., of a class of German boys of eleven years.

Mr. Vestal, Carl Schurz High School, Chicago, spoke on the devising of experiments to carry into effect the associative idea of teaching physics. He described briefly an experiment with a short transmission line to determine voltage drop and power loss. This brought on an interesting discussion.

Mr. Tower, Englewood High School, Chicago, distributed copies of a brief and interesting experiment for pupils to determine their own possible and average horse power in coming upstairs, when vertical height is known, and measuring time with a stop watch.

Mr. Harley, Hyde Park High School, Chicago, described an interesting piece of apparatus which he had found useful in protecting ammeters in electrical experiments. It consisted of a hard wood board about 10x20 inches, having three pairs of binding posts, and a double throw single pole knife switch always in series with ammeter.

SATURDAY, NOVEMBER 30, 1918.

The meeting was called to order by Chairman Ahrens at 10:45 a. m. Discussion as to whether Physics Section should meet with General Science. Mr. Turton moved that relation of general science to physics be referred to Lookout Committee to be appointed to consider reorganization of physics course in the high school.

The Nominating Committee, Chairman Mr. F. E. Goodell, Iowa City, Iowa, reported the following nominations for section officers for the ensuing year:

For Chairman—Mr. F. R. Gorton, State Normal School, Ypsilanti, Mich.

Secretary—Mr. A. W. Augur, Tilden High School, Chicago.

Vice-Chairman—Mr. A. W. Zehetner, Dubuque, Iowa.

The report of the Nominating Committee was adopted, and these officers declared chosen.

An animated discussion as to the need for a reorganization of teaching methods now took place. While there was some disagreement, it seemed to be the consensus of opinion that reorganization was necessary.

A committee to take up this matter of reorganization was then chosen by vote. Mr. A. W. Augur was chosen Chairman, with Mr. F. E. Goodell and Mr. Chas. S. Jewell, Senn High School, Chicago, as members. Mr. Augur was, by the terms of the motion creating the committee, made the section's member of the Central Committee of the Association on "The High School of Tomorrow."

Meeting adjourned.

C. L. VESTAL,
Secretary pro. tem.

GEOLOGICAL SURVEY A WAR-MAP PRINTER.

The contribution to the war of the map engraving and printing plant of the United States Geological Survey, Department of the Interior, has not been limited to the reproduction of the surveys executed by the topographic engineers, but has included the reprinting of hydrographic and British Admiralty charts in large numbers for the Navy Department and of various military maps of French and Belgian areas for the War Department. Motor-truck route maps and airplane route maps have also been compiled and printed for the use of the Army, as well as special charts and maps for use at instruction camps. An interesting use of this specially equipped printing plant has been the regular issue of camouflage charts for the Navy. The regular geologic-map work has given place during the period of the war to these exigency calls for color printing for military purposes.

THE PRACTICAL VALUE AND METHOD OF BIRD STUDY IN THE HIGH SCHOOL.

By Clarence L. Holtzman
Waller High School, Chicago.

A Chinese proverb runs, "If you have two loaves of bread, sell one and buy a lily." America puts it, "The beautiful is as useful as the useful." Now let us paraphrase it, "The useful is more beautiful than the useless." My subject limits me to the practical value of bird study, and I will enclose in this field therefore, anything which makes life more worth living, whether it be the accumulation of dollars or the joy of acquaintance with feathered folk.

If we bring the animal world before the bar of public judgment, we find the pets of the world practically limited to mammals and birds. The acknowledgment of beauty goes to insects, birds, and mammals. Our daily bread or rather meat comes from mammals, birds, fish, and mollusks. So we find birds ranking high in contributing to our necessities, our luxuries, or our pleasures.

I do not need to plead the value of bird study with you, for it is so universally recognized as to be beyond debate. What is to be the content and method of bird study may then more properly concern us. We will divide the subject into four phases: habit, economic, taxonomic, aesthetic. In my own classes I have a study of a living bird, as to structure, food, instinct, intelligence, care, etc., using ring doves, pigeons, canaries, or chickens as convenient. All of these have been kept in many laboratories with entire success. When Madeline Smith came to me and remarked, "I hear you have a chicken here. May I see him?" I sent her into my private room where the Plymouth Rock hen was setting on duck and hen eggs. She dashed out panic-stricken, exclaiming, "He growled at me." Madeline had been raised more artificially than the hen, but nevertheless she persisted in mothering the hen, chicks, and ducklings later. The colored lantern slides of poultry make an appeal to pupils which is worth while, and every laboratory should be equipped with slides showing the food and economic value of wild birds.

Should we touch on taxonomic study? Assuredly, for by having a few examples of each of several families sketched and described as to color and shape of bill and feet, we get a realization of sex coloration, adaptation, family relationship and differences, habits and relative values, which is worth while. Instead of

having birds mounted on pedestals with the single green cloth leaf attached, to be reduced soon to a mass of wreckage or kept securely protected behind glass doors, bird skins may be mounted in rectangular frames of quarter inch basswood after the type of honeycomb frames, by stretching diagonal wires through the skin and frame and binding clean photo glass into the rabbeted sides of the case. These have been handled thousands of times by youngsters eager to match the birds they had seen the day before. Numbered assignments in the case will keep the boxes fairly in order. The dead birds which are sometimes brought in may be added to the equipment by skinning, or if time or skill is lacking they may be embalmed by injecting them with full strength formaldehyde by means of a hypodermic syringe (ask a physician for a discarded antitoxin syringe).

But does the adult of thirty to X years care for structural, economic, or taxonomic study? Not at all, but rather to hear the birds and see them for the pleasure of the acquaintance, while, with many a real friendship may result.

Both the collecting and sporting inclinations of the average boy or girl may be turned to account in the spring migration study. March 1 is an important date at Waller, when each year our "Bird Record" opens. A talk is given before each class, explaining the rules of the game, the wonderful phenomena of migration, the value of birds in crop conservation and for pleasure. Very definite instructions are given as to how to stalk the quarry, the importance of characteristic movements, colors, and notes; how to judge size, and when and where to go birding. No attempt is made to take a flock of bipeds into the field, but each is urged to have a pocket guide, and to get out early, late, and often. Sharp competition soon develops, necessitating considerable care on the teacher's part in O. K.'ing reports. The first robin, crow, oriole, etc., is entered on a large wall poster with a lettering pen to the credit of the pupil first reporting the same in writing. All others lose that glory, but in order to give honor to those who see birds already reported we have the "Jacob's Ladder," a slat frame with nails on which to hang competitors' names on narrow cards with number tags alongside. Each week the complete list of each one is handed in, the cards are adjusted on the "Jacob's Ladder" in order of precedence and the lists returned for the next week's additions.

The coming of the crest of the migration wave during the first week of May means long days and short nights for the

teacher, until you demand of yourself, "Is it worth while to be a fool and pile up work for yourself, or to be a fossil and take life easy?" But when you are told that Wanless has looked forward for two years to taking biology so as to be in on the bird record, or when Mrs. Allen tells you that Richard has taken a new grip on school and is especially interested in zoology, and *will* be the first one up in the morning, and hunts birds early and late, holidays, and to and from church (I wonder if he hears the sermon?), you remember that the pay check is not the entire reward of your efforts. May 31 sees the final reports in and a summary sheet of statistics to be compiled, giving total number of birds seen by each and the number of first reports or O. K.'s credited to each one.

Proof that the bird record has a lasting influence on their lives comes from the alumni year after year. Essentially the same plan carries the flower calendar through April, May, and part of June, closing only to clear away for the end of school.

In closing, I wish to give credit to Prof. Herbert E. Walter, now of Brown University, my predecessor and colleague at Waller, for the whole plan. His skill and enthusiasm established a precedent and gave momentum which carried it through the low tide after he left.

VICTORY LIBERTY LOAN.

When the American people, in the Victory Liberty Loan next spring raise billions of dollars to pay for munitions that never reached the firing line in France, they will not in reality be paying for those munitions, but for the saving of 200,000 American lives.

It was not the American army in France that forced defeat upon Germany in 1918; it was the enormous production of munitions in this country that the German general staff knew would soon be flowing into action at the front and which would make victory impossible for the kaiser. Had it not been for this knowledge the Germans would have fought through 1919.

Our expenditures for December were the largest on record, being $2,060,000,000, a sum almost double the total annual expenditure of our Government in prewar times. Many people will call that paying for a dead horse. True, only one battery of American made artillery ever reached France. Practically none of our tanks got into action. But on the way was a stream of artillery and shells that would have blown the German army off the earth; we were beginning to deliver mustard gas ten times as fast as the Germans could make it, and our program of tanks called for one tank to every seventy-five feet of front.

Do we realize that the German army was never really routed? That to the last it was fighting on foreign soil? It was only the knowledge of this great stream of munitions on the way that ended the war in 1918 instead of 1919, and saved the lives of from 100,000 to 200,000 American boys.

RESEARCH IN PHYSICS.

Conducted by Homer L. Dodge.

State University of Iowa, Representing the American Physical Society.

It is the object of this department to present to teachers of physics the results of recent research. In so far as is possible, the articles and items will be nontechnical, and it is hoped that they will furnish material which will be of value in the classroom. Suggestions and contributions should be sent to H. L. Dodge, Department of Physics, State University of Iowa, Iowa City, Iowa.

A Thermionic Rectifier for Large Currents.

In a previous article[1] the simple thermionic valve, as used in wireless signaling, was described. We will now turn our attention to a comparatively new thermionic instrument similar in many respects to the thermionic valve but quite different in its application and manner of operation. In the former instrument the electrons necessary to carry the current are, for the most part, thermions given off by a hot filament. They are more than sufficient in number, since the currents involved are relatively small. But for the rectification of large currents at low voltages it is necessary to have a more copious supply of charged carriers or ions.

Under favorable conditions the desired ions can be produced by the ionization of a gas. Let us consider the case of a bulb B, Figure 1, filled with gas at the proper pressure, fitted with a tungsten filament F, and an anode A, made from a heavy piece of metal, usually tungsten. When the filament is heated, negative electrons are given off. If the anode is positively charged, the electrons will be drawn toward it at a high velocity and will encounter molecules of the gas. By their impact they will tear electrons from the molecules, thus ionizing the gas, producing negative ions or electrons and positive ions consisting of positively charged atoms and molecules. The newly separated electrons will join the stream already advancing toward the positively charged anode and will assist in still further ionization. Equal numbers of positive ions will stream toward the negatively charged filament. Thus the large numbers of negative electrons given off by the filament produce a vastly greater number of positive and negative ions in the gas and in this way make the tube able to carry enormously greater currents than would be possible were there no gas present.

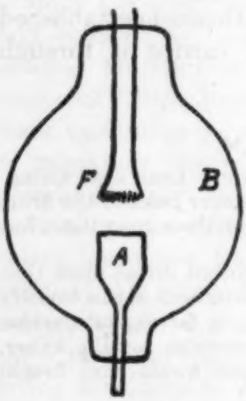


Fig. 1

In some respects the phenomenon is quite similar to electrolytic conduction, the ionization of the gas by collision taking the place of the spontaneous ionization of the electrolyte. But, on closer analysis, one finds certain essential differences. An electrolyte can carry a current in either direction. If the electrolysis is performed with an alternating current the same amount of hydrogen and oxygen appears at one electrode as at the other. The electrolytic ions travel in either direction and the whole wave of the alternating current is conducted. The situation is somewhat different in the case of the gas-filled rectifying tube, the essential difference being in the manner of ionization.

[1] "The Thermionic Valve," January 1919, page 20.

Gaseous ionization, instead of being spontaneous, is, under the conditions we are considering, caused by the bombardment of the gas molecules by electrons. This action can occur only when the filament is negative with respect to the anode. Consequently an alternating current is conducted in one direction only.

It is upon the difference in the ionizing power of the electrons and the positive ions that the rectifying effect depends. The electrons reach very high velocities under the influence of the field, but the positive ions, being atoms and molecules, are thousands of times heavier and therefore move with comparatively slow velocity and possess little, if any, ionizing power. The hot filament acts as a starter by giving off a supply of thermions. With the filament charged negatively with respect to the anode, the process of conduction continues indefinitely, as has been described. But in the case of an alternating current the filament will be charged positively during half of the time. At the instant of reversal the space between the electrodes is filled with both positive and negative ions. When the filament becomes positive it attracts to itself all of the negative ions, and at the same time the anode, now negatively charged, attracts the positive ions. A current flows while the space is being cleared of the ions, but even though the electrons in their rush for the filament produce additional ions the whole action takes such an exceedingly short time and involves such a small number of ions as compared with the flow in the original direction, that the reverse current may be entirely neglected. In order that the filament shall be the only source of the "starting" electrons, the anode must be kept from becoming hot. For this reason it is made of a massive piece of metal or of carbon.

Although the presence of gas in the tube is the logical means for increasing the current capacity, conditions under which such a scheme can be made to operate successfully have been very hard to find. The effect of the presence of a gas is not such a simple matter as one might expect, and raises many problems. In the presence of oxygen the electron emission from a pure tungsten cathode is cut down to a small fraction of what it is in a high vacuum. On the other hand, inert gases apparently have no effect. Certain impurities, even though present in minute traces, cause disintegration of the cathode filament. Other difficulties arise because the positive ions assist in this disintegration. Under conditions of low pressure they may acquire sufficient velocity so that when they strike the cathode they actually cause a chipping off of the atoms of the metal. As the pressure of the gas is increased, the free movement of the positive ions is limited and their velocity decreased but, even though the energy of the individual ions at impact is less, there are vastly more present and the difficulties caused by disintegration of the filament may not be relieved. These and many more factors enter into the design and construction of the rectifier.

The development of a practical commercial instrument has been carried out by the Research Laboratory of the General Electric Company at Schenectady, and one type, at least, is now on the market as the "Tungar Rectifier." In a few years these rectifiers will be in common use in schools, laboratories, garages, and elsewhere. They will do their work as faithfully and efficiently as the ordinary electric light, and those who use them will never realize that these apparently simple instruments are the embodiment of the results of the most profound research. These very practical results would have been impossible except for the work of the pure scientist, for the best work of modern physics and chemistry has been called upon to furnish the basis for the development of these devices.

It has been found possible by a proper adjustment of the pressure of the selected gas to reduce the disintegration of the filament to a minimum and to secure conditions for the rectification of currents of a few milliamperes up to exceedingly high values, at voltages ranging from several volts to several thousand volts. Argon, at from three to eight centimeters pressure, has been found to be one of the best gases.

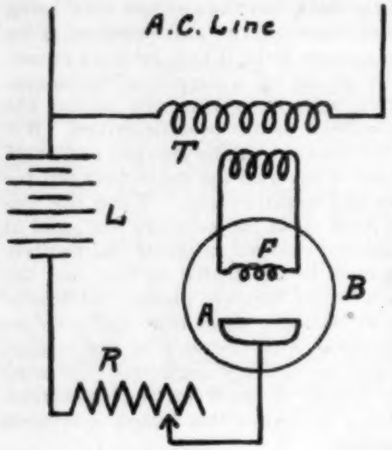


Fig. 2.

The typical circuit is shown in Figure 2. It consists of a 40-watt transformer T for filament excitation, a tube B, with filament F and anode A, a load L, and a means of regulation R. A particularly desirable characteristic of this rectifier is the self-starting feature. When the alternating current switch is closed, the cathode filament is heated. A supply of electrons is liberated from the filament and, through the mechanism of ionization, positive and negative ions are produced, causing the arc to form. If the power circuit is broken, the rectified current re-establishes itself automatically when the power circuit is again completed.

For the greatest efficiency the regulating rheostat should be eliminated. The line voltage should be transformed to such a value as will permit the load to be connected directly to the instrument. Unless a relatively large amount of power is drawn from the line, the effect upon the wave shape is negligible. If the distortion becomes objectionable, half the tubes can be connected so as to rectify one loop of the wave, while the other half rectifies the remaining loop.

It is possible to construct tubes with one filament and two anodes. Such tubes make use of the entire alternating current wave and are called full-wave rectifiers to distinguish them from the half-wave rectifiers which have been described. The efficiency of the tube will depend upon a number of factors, including the values of the applied voltage and the arc drop. The arc drop on a low current, low voltage rectifier is between four and eight volts. The energy consumed in keeping the cathode hot is forty watts. It is apparent that the efficiency under such conditions is quite high. The life of the tubes is upwards of 1,000 hours.

PROBLEM DEPARTMENT.

Conducted by J. O. Hassler,
Crane Technical High School and Junior College, Chicago.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and solve problems here proposed. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. If you have any suggestion to make, mail it to him. Address all communications to J. O. Hassler, 2337 W. 108th Place, Chicago.

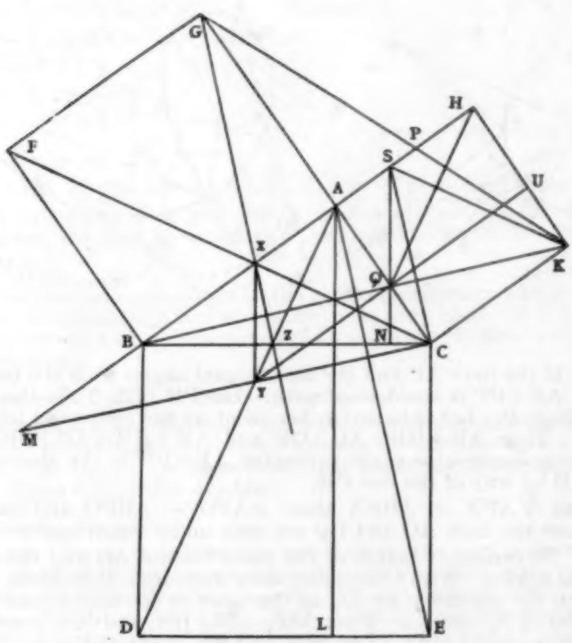
Query.

(Solution to problem 563.)

The question is raised as to whether all the statements in Philomathe's solution to 563 are justifiable by theorems of Book I as the proposed problem demands. One contributor would like to know why it is known that "XY is parallel to MF or BD." We have received the following communication from the proposer concerning this.

Amendment to Philomathe's solution, by Nelson L. Roray.

In addition to Part I [See page 659 (October, 1918).—*Ed.*]



1st. It can be proved $XA = AP = AQ$.

2nd. Take $AS = PH$. Then $SK \parallel CX$, $QH \perp SK$. $\therefore QH \parallel AY$.

3rd. $\triangle BQH \sim \triangle MYA$. $\therefore AYQH$ is a parallelogram.

4th. $QK \perp SC$. Also Q is ortho center of $\triangle BSC$ and $SQ \perp BC$. $\therefore$ $XY \parallel SQ$ since XSQY is a parallelogram.

5th. $\therefore XY \perp BC$ and Z is ortho center of $\triangle XYC$.

581. *Proposed by A. MacLeod, Aberdeen, Scotland.*

The six straight lines which trisect the angles of a triangle meet in three points which form the vertices of an equilateral triangle.

The Editor has lost the only solution (by the proposer) to this. We hope it will be reproduced later.—*Ed.*

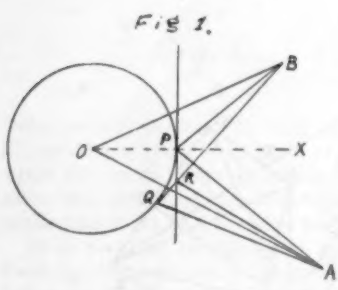
Another solution of 582.

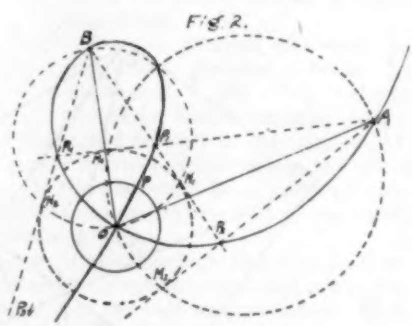
It seems evident that this problem cannot be solved by elementary geometry. Although it is our general purpose in this journal to adhere strictly to high school mathematics, we think this solution is too valuable not to be printed as was the solution in last number.—*Ed.*

582. *Proposed by A. MacLeod.*

A and B are two points outside a circle unequally distant from the center O. Find the point P on the circle such that AP+PB is a minimum.

Notes by R. M. Mathews, Central High School, Duluth.





Note 1. If the lines AP and BP make equal angles with the radial line OPX then AP+BP is the desired path. Let PR (Fig. 1) be the tangent to the circle at P. Let Q be any other point on the circle and let BQ cut PR at R. Then $AR+RB<AQ+QB$ and $AR+RB<AP+PB$, for by a well known exercise in plane geometry AP+PB is the shortest path from A to B by way of the line PR.

Again, as $\angle APX = \angle BPX$ then $\angle APO = \angle BPO$ and so P is a point whence the lines AO and BO are seen under equal angles.

Note 2. To construct points of the locus whence AO and BO are seen under equal angles. With O as center draw any circle $M_1N_1M_2N_2$ (Fig. 2); let it be cut by the circle on AO as diameter in M_1 and M_2 and by the circle on BO in N_1 and N_2. Then AM_1, AM_2, BN_1 and BN_2 are tangents to the circle centered at O. Let AM_1 and BN_1 meet at P_1. $\angle AP_1N_1 = \angle BP_1M_1$ and $\angle OP_1N_1 = \angle OP_1M_1$. Therefore $\angle OP_1A = OP_1B$ and P_1 is one of the points desired. Similarly, AM_2 and BN_2 meet in a point P_2 such that $\angle AOP_2 = \angle BOP_2$.

The angles at P_1 can be considered as described by the continuous motion of AP_1 around P_1 from A to O and then from O to B, *both angles being described in the same direction.* With this convention P_2 (where AM_2 cuts BN_1) and P_4 (where AM_1 cuts BN_2) are points of the required kind.

When successive sets of four points are constructed their locus develops as a cubic curve through A and B with double point at O. The point P required by the problem will be one of those in which the given circle O is cut by this cubic.

This cubic is very interesting from the point of view of projective geometry. The successive pairs of lines AM_1 and AM_2 constitute what is called an involution of rays at A. The same is true for those at B. Put the rays of the involution at A in correspondence with those at B by some rule and corresponding lines will intersect in points of a cubic curve. Here the rule is: be tangent to the same circle at O.

It can be proved that the bisectors of the angle AOB are the tangents to the two branches of the cubic through O.

SOLUTIONS TO PROBLEMS.

Algebra.

586. *Proposed by Philomathe, Montreal, Can.*

Solve, by Elementary Algebra:

$2x^2+\sqrt{x^2+9} = x^4-9.$

I. *Solution by the Proposer.*

The given equation may be written

$$x^2+9+\sqrt{x^2+9} = x^4+x^2, \qquad \text{whence}$$

$$(\sqrt{x^2+9}+1/2)^2 = (x^2-1/2)^2, \qquad \text{or}$$

$$\sqrt{x^2+9}+1/2 = \pm(x^2-1/2). \tag{1}$$

From (1) we derive

$$x^4-3x^2-8 = 0 \tag{2}$$

and

$$x^4-x^2-9 = 0 \tag{3}$$

The roots of (2) are $\pm\sqrt{(3\pm\sqrt{41})/2}$. These four roots satisfy the original equation. The roots of (3) are $\pm\sqrt{(1\pm\sqrt{37})/2}$. These roots are rejected, for they do not satisfy the given equation.

Editor's Note:

We feel that an explanation is due eight contributors who sent solutions incorrect or incomplete but whose methods were good. A solution to the above is correct and complete only if all roots are checked and extraneous roots rejected.

587. *Proposed by W. T. Harlow, Portland, Ore.*

A merchant takes \$1,000 every year out of his income for personal expenses. Nevertheless his capital increases every year by a third of what remains. At the end of three years it is doubled. How much had he at first? (From Chrystal's *Algebra.*)

Solution by the Editor.

Remark: Every one of the six contributors who sent incorrect solutions to this problem failed to recognize it as an indeterminate problem and some failed to interpret it properly. The merchant takes \$1,000 each year out of his *income,* not capital. His capital is increased by one-third of what remains of his income, not by one-third of his capital. It would be impossible for his capital to increase by thirds for three years and be only twice the original sum $(1+1/3+4/9+16/27>2)$. The Editor's interpretation results in the following solution.

Let x = original capital, r the rate (in hundredths) of income, or ratio of income to capital. Then income first year is rx and increase is $(rx-1000)/3$ and capital to begin second year is $(3x+rx-1000)/3$. Designate this as c_2. Then income second year is c_2r and increase is $(c_2r-1000)/3$ and capital third year is $(9x+6rx+r^2x-1000r-6000)/9 = c_3$ say. Income third year is c_3r; increase $(c_3r-1000)/3$ and, setting the capital at end of third year equal to $2x$, we have the equation

$$\frac{9x+6rx+r^2x-1000r-6000}{9}+\frac{9rx+6r^2x+r^3x-1000r^2-6000r-9000}{27} = 2x,$$

whence

$$x = 1000\frac{r^2+9r+27}{r^3+9r^2+27r-27}.$$

We notice from this result that r must be greater than .779 to make x positive, *i. e.*, the income must be about 78 per cent or more of the capital. The two lines below give the values for $r = 1, 3$.

	1″cap.	inco.	incr.	2″cap.	inco.	incr.	3″cap.	inco.	incr.	final.
$r = 1$ (100%)	3700	3700	900	4600	4600	1200	5800	5800	1600	7400
$r = 3$ (300%)	$388\frac{8}{9}$	$1166\frac{6}{9}$	$55\frac{5}{9}$	$444\frac{4}{9}$	$1333\frac{3}{9}$	$111\frac{1}{9}$	$555\frac{5}{9}$	$1666\frac{6}{9}$	$222\frac{2}{9}$	$777\frac{7}{9}$

There may be an indefinite number of solutions.
The merchant was evidently a profiteer.

588. *Proposed by Daniel Krath, Wellman, Ia.*

Given:

$y+\sqrt{y/x} = 42/x$ (1)

$x^2/3+x/2\sqrt{y} = 54/y$ (2)

Find x and y.

I. *Solution by Gertrude Buck, Adrian, Mich.*

Clear (1) of fractions and transpose,

$xy+\sqrt{xy}-42 = 0.$

$\sqrt{xy}+7 = 0$ or $\sqrt{xy}-6 = 0$

$xy = 49$ or $xy = 36.$

$\therefore x = 49/y$ or $x = 36/y.$

Substitute $36/y$ for x in (2).

$432/y^2+18/y\sqrt{y} = 54/y.$

Clear of fractions and simplify,

$3y-\sqrt{y}-24 = 0.$

$3\sqrt{y}+8 = 0$ or $\sqrt{y}-3 = 0$

$y = 64/9,\quad x = 81/16;\quad y = 9,\quad x = 4.$

Substituting $49/y$ for x in (2), we obtain in a similar manner,

$y = 2401/144,\quad x = 144/49;\quad y = 9604/729,\quad x = 729/196.$

Of these values

$x = 4$, $y = 9$ satisfy both equations.

$x = 81/16$, $y = 64/9$ are extraneous roots. Satisfy (1) but check in (2) only if we use a negative root.

$x = 144/49$, $y = 2401/144$ are extraneous roots. Satisfy (2) but check in (1) only if we use a negative root.

$x = 729/196$, $y = 9604/729$ are extraneous roots. Check in (1) and (2) only if we use negative roots.

II. *Solution by S. H. Parsons, Paris, Can.*

Clearing (1) of fractions and radicals, we have

$x^2y^2-84xy+42^2 = xy,$

a quadratic in xy which gives

$xy = 36$ or $49.$ (3)

Similarly, from (2) we have

$4x^4y^2-1305x^2y = -104976$

a quadratic in x^2y which gives

$x^2y = 144$ or $182-1/4$. (4)

Dividing (4) by (3), we have $x = 4, 2\frac{4}{9}, 5\frac{1}{16}, 3\frac{11}{16}$.

Not all of these will satisfy both equations. Finally, $x = 4$, $y = 9$.

Solutions were also received from PHILOMATHE *and* RUTH A. DAVID. *Four incorrect and two incomplete solutions were received.—Ed.*

589. *Proposed by N. P. Pandya, Amreli, Kathiawad, India.*

AB is a chord of a circle. Find a point C on AB, such that if tangents CD and CE be drawn to the circle, and if EF, parallel to AD, cuts CD in F, CD may be bisected at F.

No solutions received. It will be considered later.

590. *Proposed by Daniel Krath, Wellman, Ia.*

AB is a chord in a given circle, bisected in C. DE and FG are any two chords intersecting each other in C; FE intersects AB in H, and DG intersects AB in K. Prove that CH = CK. Geometrical and trigonometrical solutions are desired.

Two Solutions by Philomathe, Montreal, Can.

First Solution, by theory of involution.

Let us consider the quadrilateral FDGE and its diagonals FG, DE. According to Desargue's theorem on involution, we have

$$\frac{AH \cdot AK}{AC \cdot AC} = \frac{BH \cdot BK}{BC \cdot BC}.$$

Therefore, $AH \cdot AK = BH \cdot BK$, or $AH/BK = BH/AK = (AH+BH)/(BK+AK) = 1$.

Hence, $AH = BK$ and $CH = CK$.

Second Solution, by theory of transversals.

The triangle HMK, cut by FG and DE, gives

$$\frac{CH}{CK} \cdot \frac{GK}{GM} \cdot \frac{FM}{FH} = 1 \quad \text{and} \quad \frac{CH}{CK} \cdot \frac{DK}{DM} \cdot \frac{EM}{EH} = 1.$$

Therefore,

$$\frac{CH^2}{CK^2} \cdot \frac{GH \cdot DK}{FH \cdot EH} \cdot \frac{FM \cdot EM}{GM \cdot DM} = 1.$$

But $FM \cdot EM = GM \cdot DM$; therefore

$$\frac{CH^2}{CK^2} = \frac{FH \cdot EH}{GK \cdot DK} = \frac{AH \cdot BH}{AK \cdot BK} = \frac{(AC-CH)(AC+CH)}{(AC+CK)(AC-CK)} = \frac{AC^2-CH^2}{AC^2-CK^2} = \frac{AC^2}{AC^2} = 1.$$

Therefore CH = CK.

A third solution was also received from Philomathe.—Ed.

LATE SOLUTION.

583. M. G. Schucker.

Correction.

Problem 571 on p. 85 (January) should read $f(x) = 144x^4+504x^3 \cdots$ instead of $f(x) = 144x^2+504x^3 \cdots$.

PROBLEMS FOR SOLUTION.

Algebra.

Here is a puzzle. Can you solve it?—Ed.

601. *Proposed by Henry R. Hubbard, Plainsfield, N. J.*

A is now twice as old as B was when A was six years older than B is now. When B is six years older than A is now, the sum of their combined ages will equal C's age then. C is now forty six years old. How old are A and B?

602. *Proposed by Walter R. Warne, Dickinson College, Carlisle, Pa.*

P, Q, R sold 300 yards of cloth for $900. P sold an unknown quantity at an unknown price and received $300. Q sold an unknown quantity at one dollar per yard more than P and received $300. R sold an unknown quantity at one dollar per yard more than Q and received $300. Find the number of yards sold by each and their respective prices per yard.

Geometry.

603. *Proposed by M. Costello, Brentwood, Cal.*

Describe a circle tangent to two given circles and passing through a given point.

Editor's Note: This problem has practical applications. Please include remarks on the same with your solutions.

604. *Proposed by Khimji Thakkur, Urbana, Ill. (Formerly of Bombay, India).*

ABC is an equilateral triangle of side 2 inches. Circles are described with A, B, C as centers, respectively, and radii $1\frac{1}{2}$ in. Describe a circle to have an internal contact with all the three circles. Determine the radius of this circle. By the theory of centers of similarity reduce the whole figure so that the outer circle may have a radius of 2 inches.

Trigonometry.

605. *Proposed by W. W. Gorsline, Crane Junior College, Chicago.*

In the triangle ABC, if $\angle A$ is twice $\angle B$, prove $a^2 = b^2 + bc$.

SCIENCE QUESTIONS.

Conducted by Franklin T. Jones.

The Warner & Swasey Company, Cleveland, Ohio.

Readers are invited to propose questions for solution—scientific or pedagogical—and to answer questions proposed by others or by themselves. Kindly address all communications to Franklin T. Jones, 10109 Wilbur Ave., S.E., Cleveland, Ohio.

Please send examination papers on any subject or from any source to the Editor of this department. *He will reciprocate by sending you such collections of questions as may interest you and be at his disposal.*

Please send your mid-year examination papers now.

Back from War Service.

Two of the formerly regular contributors to this department are reported back from doing their duty.

Mr. Robert W. Boreman, Parkersburg, W. Va., first did research work for the Bureau of Standards and later became a naval aviator.

Mr. Niel F. Beardsley was instructor in the School of Fire for Field Artillery, Ft. Sill, Okla.

Tests in Chemistry.

New names on the list of those ready to cooperate in standardizing tests in chemistry are: T. A. Rogers, State Normal School, Stevens Point, Wis.; R. W. Boreman, Parkersburg, W. Va.; and Herman Clark, Salem, Oregon.

QUESTIONS AND PROBLEMS FOR SOLUTION.

315. *Proposed by James C. McClymont, Chester, Pa.*

How much power is developed by a man who weighs 160 pounds, walking on a level cement pavement for a distance of 300 feet, in 30 seconds?

316. *Submitted by A. H. Smith, Riverside, Cal.*

What about the science of the following clipping taken from the *San Bernardino Sun*?

"Joe Catick, mayor, is back from the mouth of Morongo Creek, ten miles north of Palm Springs, and he declares he saw a rainbow formed, not by rain, but by dust.

"It was visible and the background of hills was only eight miles away. Above the hilltop the rainbow was not visible against the sky. There was not a cloud in sight, nothing but dust blown up by the wind."

"W. P. Rowe, assistant city engineer, was with Mayor Catick and he likewise saw the 'dustbow.'

"The two men have been out in the Morongo for a number of days, working on an irrigation project."

SOLUTIONS AND ANSWERS.

311. *Proposed by A. H. Smith, Riverside, Cal.*

The "Press" of March 25, 1918, stated that it might be possible to account for the long distance (70 miles?) over which the projectiles from the long range gun were shelling Paris by assuming that one shell was inside another and that successive explosions took place during the flight of the shell. Does this statement agree with the laws of physics?

Answer by Niel F. Beardsley, Wadsworth, Ohio, formerly instructor in School of Fire for Field Artillery, Ft. Sill, Okla.

The "Press" account of successive explosions in the projectile of the German "big gun" could be according to physics. On each successive explosion the energy of motion of the whole projectile could be given to a part, resulting in an increased velocity. The probable reduced ballistic qualities of the smaller projectile though, would make the increase of range problematical. As example, the bursting of shrapnel in time fire results in an increased velocity of the balls, but due to their poor ballistic qualities they fall faster than the true trajectory.

A more probable solution of the big gun question would be high muzzle velocity—approaching a mile a second—obtained by enlarged powder chamber and long bore; high ballistic coefficient increased by having a special elongated steel cap over the forward end; and, lastly, high angle fire. The gun was doubtless fired at more than 45 degrees elevation, the purpose being that when the projectile reached an elevation of several miles where the air resistance approached the conditions of a trajectory in vacuo, the trajectory was inclined about 45 degrees—the elevation for maximum range in vacuo.

EXTRACTING NITRIC ACID FROM THE AIR.

M. Andriessen has, it is said, invented a new arc furnace which produces nitric acid in greater volume than has hitherto been possible. The arc is derived from alternating current at high tension. It crosses a current of air forced between the electrodes. The flame passes between the poles of an electromagnet which gives it a helical form, thus permitting its inclosure in a very restricted space and an energetic cooling of the nitrous gas. With an oven of 35 kw., the inventor claims to have obtained 70 g. of acid as compared with 45 g. with a Birkeland oven of the same size. It is contended, however, that this output has been equaled and even exceeded at Notodden, and that inventors should now seek above all to extract the acid from very much diluted nitrous gas in the most economic way possible.—[*Electric World.*

BOOKS RECEIVED.

The Apple, by Albert E. Wilkinson, Cornell University, pages xii +492. 15x21 cm. Cloth. 1915. $2.00. Ginn & Company, Chicago.

Unified Mathematics, by Louis C. Karpinski, University of Michigan, Harry Y. Benedict, University of Texas, and John W. Calhoun, University of Texas. Pages viii +522. 13x19 cm. Cloth. 1918. D. C. Heath & Company, Boston, Mass.

The Elements of Animal Biology, by S. J. Holmes, University of California. Pages x +402. 14x20 cm. Cloth. 1918. $1.35 net. P. Blakiston's Son & Company, Philadelphia, Pa.

Elementary Mathematical Analysis, by Charles S. Slichter, University of Wisconsin. Pages xviii +497. 13x19 cm. Cloth. 1918. $2.50. McGraw-Hill Book Company, New York City.

Solid Geometry, by Claude I. Palmer and Daniel P. Taylor, Armour Institute of Technology. Edited by George W. Myers, School of Education, University of Chicago. Pages vi +177. 12x18 cm. Cloth. 1918. Scott, Foreman & Company, Chicago.

Modern Arithmetics, Primary, Intermediate, and Upper, by Bruce M. Watson, Superintendent of Schools, Spokane, Wash., and Charles E. White, Franklin School, Syracuse. Pages viii +252, x +254, ix +302, 13x19 cm. Cloth. 1918. D. C. Heath & Company, Boston, Mass.

Trade Foundations Based on Producing Industries, by Several Vocational Instructors and Tradesmen. Pages xix +522. 16.5x23.5 cm. Cloth. 1919. Guy M. Jones Company, Pub., Indianapolis, Ind.

Modern Americans, by Chester M. Sanford and Grace A. Owen, Illinois State Normal University, Normal, Ill. 208 pages. Cloth. 1918. Laurel Book Company, Chicago.

BOOK REVIEWS.

An Introduction to the Study of Science, by Wayne P. Smith and Edmund Jewett, New York City. Pages xi +620. 14x19 cm. Cloth. 1918. $1.40. The Macmillan Company, New York City.

At present, the making of books treating of general science appears to have no end. Many splendid volumes have recently come from the press, and this book occupies a very high position in this great galaxy of general science texts. The fundamental of this book is to get the boys and girls in their first-year science in the high school familiar with the principal features of the environments in which they live.

The matter is presented, as nearly as it is possible to do, in a logical and inductive way according to the development of the pupils. Much stress is therefore placed upon the psychological or rather upon the traditional method of placing the subject.

The authors believe strongly in the experiment side of the subject, and sufficient experiments are given to show the why and the how. The experiments are not given so much for the purpose of closing the subject as to create in the pupil's mind the desire for further investigation.

Scientific facts and principles which are already known are used in such a way that the pupil may be led to interpret to the best advantage the scientific phenomenon with which he is concerned, emphasizing the important principle of actually compelling the pupil to acquire this knowledge in order that he may have a better control of the action of scientific phenomena and its influence on mankind. The project method of instruction is strongly advocated.

The book is divided into fourteen chapters and covers all the range of space that may be taught in a general science course.

There are 173 drawings and figures that have been aptly selected. Each chapter closes with a summary of the matter treated in that chapter, along with a long list of very practical questions. The book is well indexed and deserves an extensive circulation. C. H. S.

Backgrounds for Social Workers, by Edward J. Menge, University of Dallas, 214 pages. 14x20 cm. Cloth. 1918. Richard G. Badger, Publisher. The Gorham Press, Boston, Mass.

This is a splendid book which the author has put into print, and is one with which all faithful social workers should be familiar. There are nine chapters, each of which is given a special title: "Birth Control," "The Primitive Family," "The Medieval Family," etc. Many references are given to kindred works. It is well indexed, well written, and deserves an extensive sale. C. H. S.

Effective Farming, A Textbook for American Schools, by H. O. Sampson, Winthrop Normal College, Rockhill, S. C. Pages xxiii+490. 14x20 cm. Cloth. 1918. $1.32. The Macmillan Company, New York City.

A thorough, progressive, and up-to-date text relating to the subject of agriculture in the American secondary schools. Written and illustrated in such a way as to at once secure and hold the attention of the pupil. Nothing but wide-awake and up-to-date questions are considered and discussed. A book which every person interested in farming or agriculture should read and study. It is profusely illustrated, and has well-selected drawings and half tones selected only for the purpose of driving home the subjects discussed.

The author writes on the supposition that the general public should demand that the farmer be intelligent, alert, and resourceful in securing from his land, necessary food to support the general public. If the young Americans in our high schools who expect to continue the work of farming had a course in this text, they could not but be helped and stimulated in continuing their investigations in order that they may be much more efficient than otherwise in this work on the farm.

C. H. S.

Stories of Americans in the World War, by William H. Allen, Director of Institute for Public Service, and Clare Kleiser, Public School Principal, New York City. 176 pages. 13 1-2x19 cm. Paper. 1918. Institute for Public Service, 51 Chambers St., New York City.

The most interesting compilation of stories and incidents that have been largely written by doers and seers in this great contest. Each author had a particular message and naturally an inspiration to present. The stories have been more or less condensed and abridged, but the fundamental parts are still there. There are many very apt half tones presented. The book is one in which all true Americans and lovers of humanity will be interested. C. H. S.

Introduction to Organic Chemistry, by John Tappan Stoddard, Professor of Chemistry in Smith College. Second edition. Pages x+423. 2.5x12.5x17.5 cm. Cloth. 1918. Blakiston.

This revision of a most excellent introductory organic chemistry text keeps the good features of the first edition, corrects the few minor errors, makes many minor alterations, and in addition furnishes completely rewritten accounts of the natural oils and fats of uric acid and the purine bases, and of the proteins. As was the case with the first edition the presentation to beginners of the difficult subject of organic chemistry is admirably done. F. B. W.

American Red Cross Abridged Textbook on First Aid, by Colonel Charles Lynch, United States Army. First edition. 31 illustrations. 14+209 pages. 12x18 cm. Paper. 1918. 35 cents. P. Blakiston's Son & Company, Philadelphia, Pa.

A valuable book for all Red Cross and kindred workers, especially those who are working with the American soldier. The matter and methods presented are authentic without question. The methods of treatment with the sick and wounded are fully discussed, at least as much as they can be in a book of this size.

It is a book that all people who have anything to do with the sick and wounded should possess. There are fourteen chapters in which all of the common diseases and many of the different kinds of wounds are discussed, with suggestions for treatment. C. H. S.

American Red Cross Textbook on Home Hygienics and Care of the Sick, by Jane A. Delano, Red Cross Nursing Service, Revised and Rewritten by Anna H. Strong, Simmons College, Boston, Mass. Pages xv+334. 34 illustrations. 12x18 cm. Paper. 1918. 60 cents. P. Blakiston's Son & Company, Philadelphia, Pa.

A book which every woman who wishes to protect her family from preventable diseases should have in her home, as in the absence of a trained nurse it will enable her to give that intelligent care and service to the sick which is necessary prior to the arrival of a nurse and doctor. The book is one that should appeal to both men and women who are interested in the health, not only of the family, but the neighborhood and the nation, so that the greater cooperation can take place between all who are earnestly endeavoring to exterminate diseases and causes of accident, and thus increase longevity. Teachers, too, in our public schools should be familiar with the book, and just now since the war has withdrawn so many nurses and physicians from the general public, it is all the more necessary that the general public, especially the women, know of the many good things that are treated of in this little book. It is splendidly written, perfectly understandable, many questions interposed throughout, and ends with a glossary and thoroughly complete index.

C. H. S.

American Red Cross Textbook on First Aid, Woman's Edition, by Colonel Charles Lynch, United States Army. 92 figures. Pages xi+194. Paper. 1918. 35 cents. P. Blakiston's Son & Company, Philadelphiai Pa.

An admirable little book prepared especially for the women of our country, and thousands of them are ready to testify that the facts and information presented herein have been the cause of relieving innumerable cases of suffering. The book is thoroughly up-to-date, and contains practically all of the matter which any woman should know in order to give intelligent first aid. It is not only splendid for use among soldiers, but it is a book that should be used wherever people are suffering from diseases or injuries. C. H. S.

Unified Mathematics, by L. C. Karpinski, Ph. D., Associate Professor of Mathematics, University of Michigan, H. T. Benedict, Ph. D., Professor of Applied Mathematics, University of Texas, and J. W. Calhoun, M. A., Associate Professor of Pure Mathematics, University of Texas. Pages viii+522. 13.5x19 cm. 1918. $2.80. D. C. Heath & Company, Boston.

For the material of this book the essential topics of college algebra, trigonometry, and analytic geometry, which have so long been kept separate in place and use, were selected and combined with reference to their fundamental unity. In many recent textbooks in algebra a some-

what one-sided combination has been made with analytic geometry by introducing the notion of graphical representation. This has been of distinct advantage to the student and teacher, but in the present volume algebra has been combined with analytic geometry as well as analytic geometry with algebra. The advantage of this is seen clearly, for example in the chapters on transformations and substitutions, and on numerical algebraic equations. The chapters on arithmetical and geometrical series, always thought of as strictly algebraic topics, reveal the relation of these topics with the other two subjects.

While the union of these subjects has been made with such good judgment that it alone would justify the production and wide use of this book, there is another feature which greatly increases its value to the student. He finds principles illustrated by problems from fields in which he has had real experience, and applications of these principles in the fields of his present and future endeavor. The numerous applications of the conic sections, for example, show the student the usefulness of analytic geometry and the need of gaining command of this tool. Throughout the book there are "real problems" that connect theory with vital problems of the world's work. The historical notes, well-drawn diagrams, and photographic illustrations, together with genuine unification of mathematical material and live problems, make this a textbook of unusual merit.

H. E. C.

Civic Biology, by Clifton Hodge, University of Oregon, and Jean Dawson, Department of Sanitation, Cleveland, Ohio. 381 pages. 13x19 cm. 172 illustrations (4 colored plates). Ginn & Company.

One scarcely knows what to say about such a book as this; it cannot be measured by ordinary standards. It is not an ordinary book. Anyone knowing the authors and their work in civic biology would expect something original and intensive from them when they set out to prepare a textbook. No biology teacher should fail to possess the book—for his own good and that of his pupils. As to whether the average teacher

could live up to it—use it successfully—we do not know, but we do know that there is much stimulation in reading the book.

The subtitle is illuminating—"A Textbook of Problems, Local and National, That Can Be Solved Only by Civic Cooperation." And again in the preface, the authors say: "Discovery is pushing forward in every direction as never before in the history of the world, and still it would seem that enough is already known to make living well-nigh ideal, and the world almost ideal, if only *enough* people knew." "The problem of biology is therefore, to make it possible for everyone to know what these forces (biological) are, for good or for ill, and to understand how to do his part for his own good and for that of the community."

We are not sure that a book that plays up the destructive forces of biology so strongly is altogether a good one for the pupils or best for carrying out its professed purpose. Perhaps there is such a thing as overdoing the business. Practically the entire book is given over to the harmful forces at work. There is comparatively little of the beautiful and really wonderful operations of nature which are all around us. For example, there are only four chapters relating to plants aside from the fungi and bacteria—out of thirty-two chapters—and considerable parts of these four chapters are taken up with weeds, poisonous plants, forest fires, and the like. There is scarcely nothing about flowers, fruits, and seeds, about how plants live, how they make their food, and many other such problems. Is it not possible that people should know about the normal lives of normal animals and plants in order to appreciate the civic problems that grow out of the lives of certain special forms?

However, the book is exceedingly stimulating, and should be studied by all biology teachers whether or not they use it as a text.

W. W.

Main Currents of Zoology, by William A. Locy, Northwestern University. 216 pages. 13x17 cm. 33 plates. $1.35. Henry Holt & Company.

Dr. Locy is the author of *Biology and Its Makers*, a book well known to all biology students. The present book is limited to zoology, and as the title indicates takes up the lines of discovery and advance—the "main currents"—in zoology. The great zoologists are not discussed personally, only as their work enters into these main currents of discovery. The book is extremely interesting and illuminating. There are 33 plates of eminent zoologists—a collection under one cover worth the price of the book. W. W.

Laboratory Manual in Field Crops, by Chester C. Farr, State College of Washington. 63 pages. 13x17 cm. Illustrations in text. 52 cents. The Macmillan Company.

There are 44 "practicums" on various field crops in the book. It covers all the more common crops, the cereals, forage and grass crops, legumes, root crops, flax, and cotton. The practicums seem to be excellent. One notices immediately that they are short—they leave something for the pupil to work out for himself. Too many outlines are fussy, they ask too many questions and tend to induce reliance upon the text rather than vigorous thinking. The book will be a useful reference book for teachers of botany and agriculture, and can be used to advantage in some high schools with advanced work in agriculture. W. W.

The Geology of Vancouver and Vicinity, by M. J. Burwash. Pages v+106. 17x25 cm. Paper. 1918. $1.50. University of Chicago Press.

To those people who are interested in the geology of the extreme Northwest of the United States, and British Columbia especially, this work by Mr. Burwash on Vancouver and vicinity will be extremely welcome.

SOME of our contributors for April will be:

Dr. B. S. HOPKINS,
University of Illinois

DR. DANIEL R. HODGDON,
Technical School, Newark, N. J.

MRS. NELL J. SANDERS,
Calumet High School, Chicago

C. F. MILLER,
Superintendent of School, Normal, Illinois

ALEITA HOPPING,
De Witt Clinton High School, New York City

BENJAMIN C. GRUENBERY,
Julia Richman High School, New York City

RAYMOND J. POOL,
University of Nebraska

DR. G. A. MILLER,
University of Illinois

The author has made this particular section of the earth an intensive study, and has brought both the physiographic description as well as the geology of this region. There are several maps and half tones presented. It is a book that will be welcomed by all students of geology.

C. H. S.

The Carnegie Foundation for the Advancement of Teaching—Pensions for Public School Teachers, by Clyde Furst and L. L. Kandel. Pages xi+85. 19x25 cm. Paper. 1918. The Carnegie Foundation, 576 Fith Ave., New York City, N. Y.

The issuing of this splendid work will undoubtedly bring the public school-teachers of the United States more closely in touch with the Carnegie Foundation than they ever have been before, as it strikes at a very vital point in their career.

This bulletin delves into every pension system for teachers in the United States, and presents its reasons for believing that a great number of them are unjust and financially unsound, and the reasons for these conclusions are given in the report.

There is presented a plan by means of which a financially sound system might be established in every state in the Union. The first few pages are devoted to the philosophy of pensions, followed by the discussion in report on the present status of teachers' pensions, and finally, a suggested system as found in the state of Vermont.

There is a brief bibliography and a complete index, as well as a tabulated statement of the form of pensions in practically every state in the Union.

It is a report that all teachers should carefully study.

C. H. S.

Physical Apparatus for Educational Institutions. 230 pages. 20x27 cm. Paper. 1918. The Central Scientific Company, Chicago, Ill.

This is the very latest edition of the catalog gotten out by this thoroughly up-to-date scientific supply house. One discovers many new forms of apparatus from the last issue of their catalogue.

The cuts are remarkably well made, and illustrate perfectly the kind of apparatus, so that a prospective purchaser will secure the right idea of the machine or device from an inspection of the catalog. The cuts appear at the top of the pages, whereas the descriptive matter, price list, size, and so forth, are found at the bottom of the corresponding pages.

Directions for ordering and getting in touch with the firm are given in the first part of the book.

The prices quoted are as low as can be given, and one understands perfectly in these strenuous times that prices are liable to fluctuate even from day to day.

Apparatus buyers will make no mistake in placing their orders with this firm. C. H. S.

Starved Rock State Park and Its Environs, by Carl O. Sauer, Gilbert H. Cady, and Henry C. Cowles. Pages x+148. 17x15 cm. Cloth. 1918. $2.00 net, with postage extra. University of Chicago Press.

To the people, especially of the state of Illinois, this is a welcome contribution, not only to the literature of the state, but to the history, geography, and geology of the same. There are none more competent to produce a book like this than the authors of this splendid book. They have made a thorough study of all phases of the country surrounding this historic Starved Rock Park.

This book was written especially for the Geographical Society of Chicago, which society was one of the main factors in the establishment of this particular park.

It is divided into three parts—first of geography, second geology, and third botany. There are forty diagrams and half tones, besides two maps inserted in the pocket in the rear cover. One, a geological map of the Park and adjoining area, and the other, a geographical map of the same territory.

The book has a splendid index appended, and is a book that all lovers of the history and geography of the state of Illinois should possess.

C. H. S.

America and Britain, A Story of the Relations Between the Two Peoples, by H. H. Powers. Pages iv+76. 11.5x14.5 cm. Cardboard. 1918. 40 cents. Macmillan Company, New York City.

This little book is an interesting story of our relations with the people of Great Britain and her colonies. The book goes to show that those Americans who have studied the situation of the British colonies are in complete accord with that greatest democracy, Great Britain.

The international relations between the two countries is discussed in a very fair manner. It is a little book that will be helpful to all people who wish to familiarize themselves more with the relationship existing between these two great nations.

C. H. S.

A Handbook of Physics Measurements, by Ervin S. Ferry, Purdue University. Volume I. Fundamental Measurements, Properties of Matter and Optics. Pages ix+251. 16x20.5 cm. Cloth. 1918. 146 figures. $2.00 net. *Volume II. Vibratory Motion, Sound, Heat, Electricity, and Magnetism.* Pages x+233. 16x20.5 cm. Cloth. 1918. $2.00 net. John Wiley & Sons, New York City.

Space will not permit the extensive review of these two splendid volumes which they merit. The author of them has presented in the most interesting and carefully prepared way many of the older well-known experiments, as well as many new ones, and new methods of doing both the old and the new experiments.

They are books that very largely belong to college and university work, yet, at the same time, the high school instructor will find therein much valuable information and many suggestions that will help him not only in his text work, but especially in his laboratory work.

There really is nothing omitted from any of the experiments discussed. The books are written in a very understandable way, and the mathematics that are necessary are given in connection with the experiments, although a great number of the experiments require no mathematics beyond trigonometry or college algebra.

There are many tables appended, and each volume also has a very complete index. They are books that all physics instructors should possess.

C. H. S.

The Carnegie Foundation for the Advancement of Teaching—A Study of Engineering Education, by Charles R. Mann. Pages xi+139. 19x25 cm. Paper. 1918. The Carnegie Foundation, 576 Fifth Ave., New York City, N. Y.

Two or three years ago this Foundation deemed it wise to make a thorough survey of the condition of engineering education in the United States, and succeeded in securing Professor Charles R. Mann, at that time of the University of Chicago, to undertake this work. No one was better qualified than he to make this important study.

The book is surely a valuable contribution, not only to the study of engineering education, but to education in general, and should be found in the library of all persons interested in education.

It Does Away With the Old Cumbersome Lantern-Slide Holder

A RELIC OF A QUARTER CENTURY AGO

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It consists of three parts: Part I discussing present conditions; Part II, the problems confronting engineering education; and Part III suggesting solutions of problems.

There is a selected bibliography of papers bearing upon and closely connected with the work.

There are seven double pages in a complete index, and the Foundation is to be complimented on publication of this important work.

C. H. S.

A Textbook in General Science and the Economics of Daily Life, by Herbert Brownell, University of Nebraska. Pages xi+383. 14x20 cm. Cloth. 1918. $1.00 net. Blakiston & Son Company, Philadelphia.

This is one of the really great texts on this subject which has appeared in the last few years. The author is more than a master of his subject, being a teacher of long experience.

This book is the product of the experience that he has gathered by close contact, not only with secondary school pupils, but in the school of education in the University of Nebraska with which he is connected.

The author believes that a textbook of this kind should be compiled in such a way as to give pupils who use it a desire for a knowledge of the science of the affairs with which they are daily concerned, especially as they find them in their daily life and home. C. H. S.

Elementary General Science, by Daniel R. Hogden, State Normal School, Newark, N. J. Pages xxii+553. Cloth. 1918. $1.50. Hinds, Hayden & Eldredge, New York City.

This book has been prepared by one who is more than competent to write on the subject of general science, as he is one who has had many years of experience in all lines of science teaching, and has thus concerned himself with not only the subject matter which such a book should contain, but has also familiarized himself with the methods of presenting such material.

The author has experimented for several years with various methods of presenting the subject matter of general science so as to most readily attract the attention and the interest of the pupil.

As the text indicates, he is thoroughly convinced of the question method of instruction. The book is very largely centered upon the physics, chemistry, and biology of the home. The author has undoubtedly been impressed with the idea that the pupil should be made more familiar with the science which centers around the ideal American home, barn, garden, pond, and farm.

The subject matter is presented in a concise and interesting manner, so that the attention of the pupil is at once secured and held. The subject matter is entirely within the comprehension of the first- and second-year high school pupil. There is sufficient matter in the text so that the instructor can spread the work over an entire year. Yet the teacher may omit certain parts and complete the work within one semester.

It is not necessary to use a manual in connection with the text, as there are about one hundred experiments given, which of themselves constitute a splendid manual. The book is especially strong in the adoption of safety first and emergency treatments. This is especially true with the so-called patent medicines which are portrayed in their true life.

There are about four hundred drawings and half tones which have been selected with great care to present clearly and faithfully the points discussed. There are scattered throughout the book a thousand or more practical questions.

Mechanically, the book is well made, will stand rough usage, the paper is of good quality, and all major paragraphs begin in bold-face type.

It is a book that deserves the attention of all teachers and superintendents, who are contemplating the introduction of general science into their schools.
C. H. S.

Experimental General Science, by Willard N. Clute, Flower High School, Chicago. Pages xv+303. 12.5x19 cm. Cloth. 1917. P. Blakiston's Son & Company, Philadelphia, Pa.

After winning the fight for a place in the curriculum of high schools, general science is passing through the stage of pedagogical experiment as to what are the topics that rightfully belong in a first-year subject, and how they ought to be treated. The author of Experimental General Science does not hesitate to take the position that such a text should be a summary of the fundamental principles from all the natural sciences, merely simplified to suit the understanding of children. Among the topics noted for discussion are deliquescence (114), capillarity (114), solute (129), molecular theory of matter (136), flocculation (139), Mutation Theory (227), Mendel's Law (229), catalyzers (28), five oxygen combinations (29), chemical formulas (29), and chemical reactions to be written out (147). It may well be questioned whether the college student could give clear definitions of these terms—to say nothing of a child of twelve or fourteen. Mr. Clute, however, is a scholar of maturity so zealous in his work of teaching, so eager to arouse the flagging interest of potential pupils by suggestions of many topics, that he unconsciously overshoots the mark. His teacher's attitude appears to the best advantage at the close of the various chapters, where with characteristic pose the teacher leans over the desk and asks, "Now, boys and girls, what have we been talking about?"

The ideal book of the future on general science will BEGIN with these reactions of the child to his environment, rather than end with them. A real laboratory exercise will be given at the beginning of each chapter, with a view to explaining some phenomenon the student has already shown an interest in, but could find little or no explanation of elsewhere. Till authors of general science generally get this point of view, the writer of this article sees no reason to look for any real improvement in the pedagogy of the subject. Not more books are needed, but books written by authors who can write from the viewpoint of childhood!
T. L. H.

The Beginnings of Science, by Edward J. Menge, University of Dallas. 256 pages. 14x20 cm. Cloth. 1918. Richard G. Badger, Publisher, Gorham Press, Boston, Mass.

This book is very timely as it fills a need which has long existed. Very little has heretofore been published describing the relationship between philosophy and the laboratory sciences. Much of the material presented in this book has been used by the author in the past few years in his classroom and the public lectures which he has delivered.

The book lays considerable stress on the value and importance in the laboratory work of distinguishing between facts and interpretations, calling attention to the condition that in much laboratory work there is a lack of logical and philosophical thinking, permitting the student to assume that because an hypothesis is necessary for experimental purposes, that it must certainly be true.

It is a book that all teachers of psychology and laboratory work should possess in order that they may make this work more efficient. There is a splendid chapter at the end of the book in which references are given to many books appearing on psychology and a splendid index is appended.
C. H. S.